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LOUISVILLE, KENTUCKY--INDIANA METROPOLITAN REGION SOLID WASTE DISPOSAL STUDY. VOLUME I. JEFFERSON COUNTY, KENTUCKY

John E. Heer, et al

Louisville University
Louisville, Kentucky

1970

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LOUISVILLE, KY.--IND. METROPOLITAN REGION

SOLID WASTE DISPOSAL STUDY

Interim Report on a Solid Waste Demonstration Project

Volume I: Jefferson County, Kentucky

This report was prepared by
the Institute of Industrial Research, University of Louisville,
under Grant G06-EC-00007 from the Bureau of Solid Waste Management

Details of illustrations in
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U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Environmental Health Service
Bureau of Solid Waste Management
1970

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FOREWORD

An estimated 900 million pounds of wastes in the solid state are produced in the United States every day. What to do with these solid wastes, how to dispose of them without needlessly endangering public health and welfare, and how to recover and reuse valuable materials now "thrown away" are among the most challenging and perplexing of current national problems. Because of lack of suitable planning, interest, and public understanding, these problems have reached such proportions that nationwide attention is demanded and action for the development of adequate solutions must be taken.

Intensified action concerning these problems was made possible by the Solid Waste Disposal Act, Title II of Public Law 89-272, which was signed by the President on October 20, 1965. This legislation directs the Secretary of the Department of Health, Education, and Welfare to initiate, encourage, and support a national program aimed at discovering and evaluating better methods of coping with the solid waste problem.

The Secretary is authorized: (1) to conduct and support research on the nature and scope of the problem, on methods of more safely and efficiently collecting and disposing of solid wastes, and on techniques for recovering from solid wastes potentially valuable materials and energy; (2) to provide training and financial and technical assistance to local and State agencies and other organizations in the planning, development, and conduct of solid waste management programs; (3) to encourage and support projects that may demonstrate new and improved methods of solid waste collection, handling, and disposal. The Bureau of Solid Waste Management carries out these responsibilities.

Among these responsibilities, the Bureau provides grant support for demonstrations relating to the development and application of new and improved methods of solid waste collection, storage, processing, and ultimate disposal; and grants for studies and investigations that may lead to a demonstration of improved disposal practices, or may provide solutions for regional or national solid waste disposal problems. Associated with this is the responsibility for collecting and making available by appropriate means the results of, and other information pertaining to, such federally supported demonstrations, studies, and investigations.

In order to disseminate the latest information and findings resulting from the present study as quickly as possible, this report, covering the Jefferson County, Kentucky, portion of the study, has been reproduced as received from the grantee. We trust that it will provide those working in the field of solid waste management with information that will be useful in developing approaches to the solutions of solid waste problems.

Additional work is currently underway to complete the project. Future reports will also be made available by the Bureau of Solid Waste Management.

--RICHARD D. VAUGHAN, *Director*
Bureau of Solid Waste Management

PREFACE

This report was prepared by personnel from the Institute of Industrial Research, University of Louisville. It results from studies and investigations conducted by the Institute to determine types and quantities of solid waste generated by residential, commercial, and industrial sources in Jefferson County, Kentucky. This data is utilized in a computer planning model developed by the Institute to select the most practical and economical transfer and disposal system for the County.

Similar studies are ongoing in the adjoining counties of Floyd and Clark Counties, Indiana, and these results as well as the regional plan will be presented in a future report.

Review of this report by the Bureau of Solid Waste Management indicated that it would be desirable to have the procedures followed in this study and the models developed described in greater detail, particularly the sampling analysis and the linear program formulation and results. Accordingly, it is planned that this information will be present in a future appendix volume. We hope that this report and future volumes will be of value to those who are interested in pursuing similar lines of work.

The study was supported, in part, by demonstration grant G06-EC-00007, made to the University by the Bureau of Solid Waste Management under provisions of the Solid Waste Disposal Act (PL 89-272).

--ANTON J. MUHICH, *Director*
Division of Demonstration Operations

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This report was prepared by the following personnel of the University of Louisville Institute of Industrial Research: Dr. John E. Heer, Project Director; Mr. Stephen M. Thrasher, Jr., Project Engineer; Mr. George T. Calvert, Project Engineer. It was prepared for: the Jefferson County Fiscal Court; the Falls of the Ohio Metropolitan Council of Governments; the U.S. Department of Health, Education, and Welfare, Public Health Service.

Development of the report was made possible by the cooperation of many persons and organizations contacted during the study period. Special acknowledgment is due the following:

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Mr. Charles F. Bennett, Louisville Incinerator
Mr. Hugh J. Ungerleider, Commercial Disposal Company
Mr. Harry Kletter, Industrial Services of America
Mr. Max Hyman, Industrial Disposal Company
The Jefferson Haulers Association

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Introduction

A. Study Objectives

The objectives of the Jefferson County Solid Waste Study were as follows:

1. Investigate the quantities and composition of solid wastes generated in Jefferson County and its municipalities.
2. Investigate the geographic distribution of solid wastes generated and the effect of this distribution on the location of future disposal facilities.
3. Investigate and study methods of disposal most suited to the area and type of waste generated.
4. Investigate possible sites for future disposal facilities.
5. Recommend a short term solution to alleviate Jefferson County's immediate solid waste disposal problem.
6. Develop a long-range program to insure continuing effective solid waste disposal for Jefferson County.
7. Develop an approach to solving solid wastes disposal problems of a multi-community region served by a multiplicity of refuse collection and disposal agencies.

B. Project Scope

Solid wastes considered included domestic garbage and trash, commercial and industrial non-liquid refuse, incinerator ash, junk, discarded automobiles, sewage sludge, municipal and institutional rubbish, and demolition and construction wastes.

Estimates of present and future refuse quantities were developed from population and industrial growth projections by Hammer and Company Associates, and Arthur D. Little Company, past records of municipal and private refuse haulers, incinerator records, domestic and commercial sampling studies, questionnaires, personal interview with representatives of local industry and business, and observations of refuse entering major disposal sites in the county.

Unit values were developed expressing refuse quantities in terms of pounds per capita per day or pounds per employee per day and these were applied to demographic information supplied by the Jefferson County Planning Commission to determine the distribution of refuse sources within the county.

All major disposal sites operating in the county were visited and surveyed. Where weight or volume records were not available estimates were made of the daily loading of each facility. The maximum capacity and life expectancy of each disposal site was estimated. Current operating costs were determined for the Louisville incinerator and cost estimates made for the privately owned landfills.

Disposal methods currently available were carefully studied and compared on the basis of economic and aesthetic suitability. Solid wastes disposal techniques in the research or early development stages were also investigated and evaluated as to future feasibility. Costs comparisons of new disposal methods with current methods were made whenever possible.

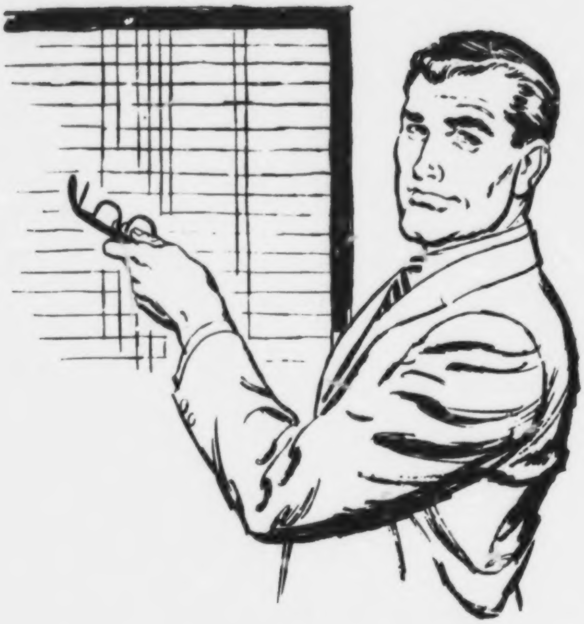
Selections of potential transfer facilities and disposal sites were coordinated with county planning and health agencies to insure compatibility with other community planning goals. In some cases more than one type disposal facility was investigated for a particular site.

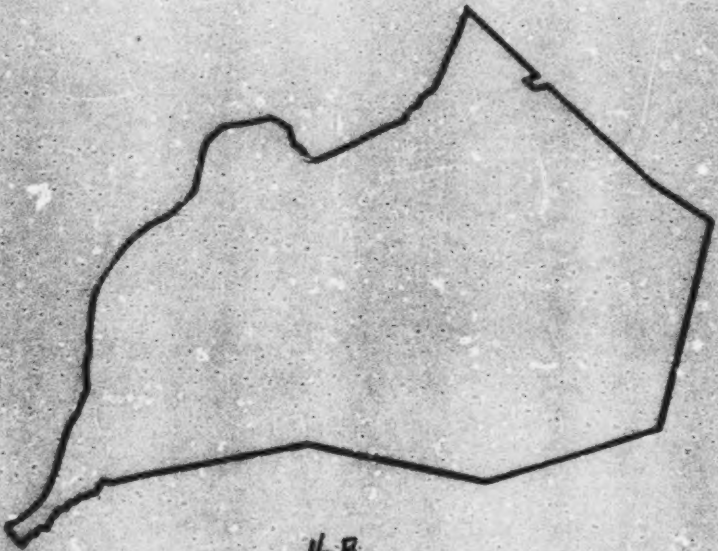
Present methods of transporting solid wastes were studied and hauling costs estimated. New modes of refuse transportation, such as pipe-line or rail transfer, were evaluated for possible use in the future. In accordance with stated project objectives, collection methods and techniques were considered outside the scope of this study, and are specifically excluded from this report.

A linear programming model was developed to determine the locations and types of disposal facilities which would result in the most economical disposal system for Jefferson County. Although the optimum system was based on minimum cost, other considerations, such as aesthetics were included in selecting the model constraints. The primary function of the model was to evaluate competitive systems and aid in development of general long-range plans, rather than simulate the existing disposal system.

A short-term plan was developed to provide Jefferson County relief from its immediate and serious solid waste disposal problems. In addition, however, long-range programs were developed, based on current and experimental disposal methods, to provide for solid wastes disposal until 1990. The program considers the types and quantities of wastes expected to be produced within Jefferson County and a mechanism is provided to permit evaluation of future disposal techniques for possible inclusion in the county disposal system.

PART I: SUMMARY OF STUDY RESULTS





I. SUMMARY OF STUDY RESULTS

I-A. Findings

The research and investigations conducted and the findings resulting therefrom are discussed in detail in the text of the report. For convenience, the principal findings are summarized here.

1. Current Conditions

a. Collection - Municipal collection of residential wastes is provided by the cities of Louisville, Shively and Audubon Park. All other incorporated and unincorporated areas of Jefferson County rely on private haulers for collection of residential refuse.

Although Louisville offers limited collection service for commercial and industrial firms located within city limits, most refuse of this type is collected by private haulers.

b. Disposal - All domestic refuse from the city of Louisville is incinerated at the Meriwether incinerator. This incinerator plant also handles large quantities of commercial and industrial wastes from private refuse collectors. The Meriwether plant contains four 250 ton rotary kiln furnaces, and is frequently loaded beyond its design capacity of 1000 tons per day. Domestic refuse from areas of Jefferson County other than Louisville is taken to either of two privately owned and operated landfills; one in the western portion of the county at the foot of Lee's Lane, and one in the east (on Ash Avenue) on the Jefferson-Oldham County line. The city of Louisville also operates a landfill on the northern edge of the county between River Road and Interstate-71. This site is restricted to incinerator residue, junk, and waste from the Parks Department and the Metropolitan Sewer District.

The increasing quantities of solid wastes, together with the fact that Jefferson County haulers have been barred from using disposal sites in neighboring counties, has placed a heavy load on existing disposal facilities.

The existing incinerator may require additional air pollution controls in the near future to comply with more stringent codes. Existing landfills are uneconomically located for many areas of this county (and will probably be exhausted within five years). Present landfill operators will be forced to improve their operations to meet new state standards for sanitary landfills. Although the effect of these new standards on existing landfill practices in Jefferson County is not known, operating costs will undoubtedly be increased.

2. Refuse Quantities and Projections

Approximately 2800 tons of refuse are being generated daily in Jefferson County; about half of this is incinerable. The total quantity of refuse is expected to increase to approximately 4800 tons per day by 1995.

a. Domestic Refuse - Residential households produce about two pounds of refuse per capita per day. Approximately 700 tons of refuse from this source is generated daily in Jefferson County. The two major components of refuse are paper and paper products comprising about 59.7% of the total by weight and putrecible foodstuffs, or garbage, comprising about 19.7% of the total by weight.

b. Commercial Refuse - Between 250 and 300 tons of this type refuse is produced daily in Jefferson County. Commercial refuse quantities vary widely with the type and size of enterprise, but on the average, commercial businesses produce about 4.6 pounds of refuse daily per employee. The composition of the combined commercial refuse output in Jefferson County is very similar to that of residential refuse, with paper and garbage the predominate components.

c. Industrial Refuse - Approximately 1400 tons of refuse is produced daily by Jefferson County industries. Of this total quantity about 21% is salvaged, 52% is collected by private and municipal haulers and enters the community disposal system, and 27% is disposed of by industry on its own property. Industrial refuse is so diversified that it is impractical to make generalizations regarding its composition.

d. Municipal Refuse - About 250 tons of refuse is generated each day from activities related to normal municipal functions. The primary contributions are: Schools, 36 tons per day; Junk pick-ups, 35 tons per day; Street sweepings, 30 tons per day; and the sewage treatment plant sludge, 150 tons per day.

e. Demolition and Construction Refuse - These activities produce about 250 tons of refuse daily in Jefferson County. Although some of these wastes are taken to the major landfills, a large portion is used to fill small holes on private property.

3. Alternate Disposal Methods

a. Landfill - Sanitary landfill is recommended as the primary disposal method for Jefferson County for the next fifteen to twenty years. Sanitary landfill is the most economical disposal method currently available. Properly operated, a landfill disposal site need not be objectionable from either a health or aesthetic standpoint. In addition to being a low cost disposal method, landfill can also be used to reclaim marginal land. The widely used practices of open dumping and burning have made any type of landfill operations distasteful to many people, and it may be difficult to sell the public on the use of sanitary landfill in spite of its economy.

b. Incineration - Modern incineration is widely used as a refuse disposal method. Incineration does not eliminate the need for landfilling. Depending on incinerator design and refuse characteristics incinerator residue quantities can range from 15 to 30 per cent of input by volume. This residue is much cleaner and more compact than raw refuse and is a somewhat more superior fill material.

Incineration is expensive relative to landfill, costing an estimated four to six times as much in the Jefferson County area. Incinerators are economical when land values are high and landfill sites located long distances from refuse sources. Most existing incinerators, including Louisville's present one, are plagued by air pollution problems. New, more stringent, air pollution codes currently being adopted by most metropolitan areas, will also substantially increase the cost of new incinerators.

c. Composting - Composting has not proven feasible in this country. High processing costs, objectionable odors, and lack of a suitable market have combined to cause the failure of almost all U. S. composting plants. This disposal method is not recommended for this area in the foreseeable future.

d. Rail Haul - The obvious advantage of transporting refuse by rail to distant strip mines is that the wastes are removed from the area entirely, and this is often desirable from an aesthetic standpoint. At present, however, techniques for rail transfer of refuse are still in the developmental stage. In the few instances of actual contracts for refuse disposal by this method, the costs have been about four times the cost of landfill in this area; this cost is approximately equal to the lower incinerator costs.

I-B Recommendations

The recommendations developed as a result of this study are presented in this section.

1. Sanitary landfill is the recommended method of refuse disposal in Jefferson County for the immediate future.

2. Additional conventional incineration facilities are not recommended because:

   a. High capital and operation costs;

   b. The fact that less than half of the solid wastes in Jefferson County can be reduced by conventional incineration;

   c. Current research and development in the area of solid waste disposal will probably make conventional incineration obsolete within ten to fifteen years.

3. Jefferson County should develop and implement a program of public information and public relations to sell the general public on sanitary landfill as a disposal method. This cannot be overemphasized. Sanitary landfill has traditionally met with stiff public opposition, which has often led other localities to adopt disposal methods which are more costly and less reliable.

4. Establishment of at least one county operated landfill is recommended. Although private landfills will play an important part in the county refuse disposal system for sometime to come, a county site will increase the reliabilty of the system as a whole and serve as a standard for landfill operations.

5. The possibilities of reclaiming refuse through salvage should be considered in construction of transfer facilities. Salvage of paper products from industrial and commercial refuse is a distinct possibility, but is probably not feasible with domestic refuse because of the collection modes now used in Jefferson County.

6. Destruction of refuse at extremely high temperatures is now being studied by several groups. This may prove to be a major breakthrough in solid wastes disposal technology. It is recommended that research efforts in this area be followed closely, with an eye toward future requirements when landfill sites are no longer available.

7. Composting is not recommended as a disposal method now or in the forseeable future, although current research may develop processes which will make composting feasible at some later time.

8. Transfer of refuse to remote sites via rail is not recommended at this time. When landfilling within Jefferson County is no longer feasible, however, rail haul may be preferred to conventional incineration, depending on the economic conditions prevailing at that time.

9. Barge transfer of refuse to remote sites is not recommended now or in the forseeable future. The refuse volumes generated daily in Jefferson County will not justify barge transfer for many years.

10. Jefferson County should work with the surrounding counties, both in Kentucky and Indiana, in developing a regional approach to solid waste disposal. Within ten to

fifteen years residential growth and rising land costs may make landfill within the county infeasible. At that time refuse must be transferred to neighboring counties or much more expensive disposal methods, such as long distance rail transfer or high temperature destruction will be required.

11. The new developments in solid waste technology should be evaluated as they appear to determine their feasibility in Jefferson County. This study should be updated periodically to include changing conditions that may affect the solid waste disposal system.

PART II: CURRENT CONDITIONS IN STUDY AREA

II. CURRENT CONDITIONS IN STUDY AREA

II-A. General Description of Study Area

Jefferson County, Kentucky, is located on the Ohio River (the northern boundary of the state) about midway between the eastern and western boundaries of the state as shown in Figure 1 . It comprises an area of approximately 250 square miles and is one of three counties comprising the Louisville Standard Metropolitan Statistical Area as shown in Figures 1 and 2 . Floyd and Clark Counties, Indiana, are the other two counties included in the Louisville SMSA, which ranks as the thirty-second largest in the nation.

1. Population

The majority of the area's population resides in Jefferson County as shown in Table 1 . Jefferson County is the leading industrial-commercial area in Kentucky and is a major regional center serving a substantial portion of the Central United States.

2. Government

In addition to the County Fiscal Court, which exercises certain limited taxation rights over the entire county, there are some 63 autonomous municipalities of varying sizes located within Jefferson County.

The principal city of the area is Louisville, containing some 60% of the county population and 51% of the total SMSA population. The other two municipalities of appreciable size are the fourth-class cities of Shively in the western portion of the county and St. Matthews in the east. The remaining governmental jurisdictions are fifth and sixth class cities, usually covering only a few square blocks in area, and almost wholly residential in character. A list of all municipalities and their populations is given in Table 2 .

TABLE 1

DISTRIBUTION OF POPULATION - LOUISVILLE AREA
(1964 Special Census)

Jefferson County (84.5% of SMSA)		
City of Louisville	392,700	59.3%
Smaller cities	71,600	10.8
Remainder of county	197,900	29.9
Total population of county	662,200	100.0%
Clark County (8.6% of SMSA)		
Total population of county	66,174	
Floyd County (6.9% of SMSA)		
Total population of county	52,994	
Total SMSA	781,368	

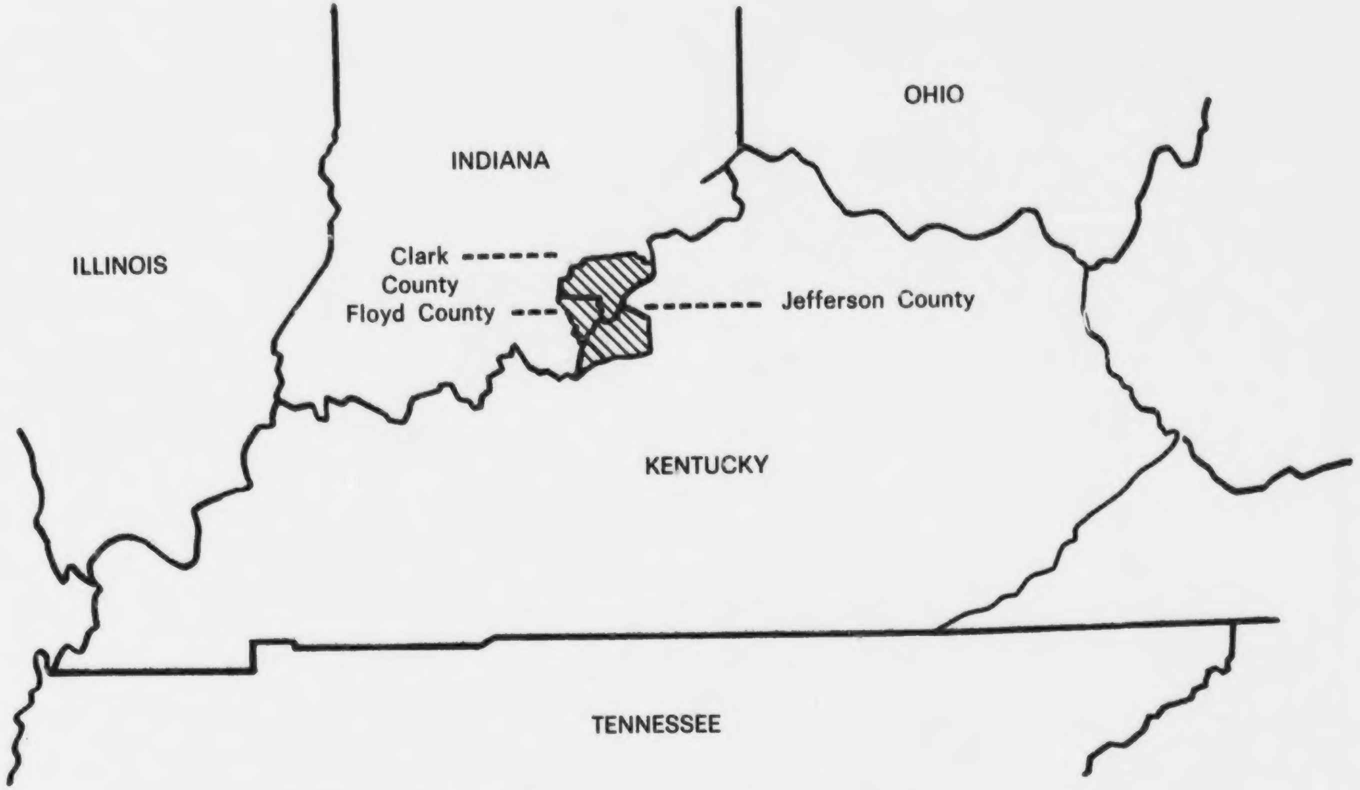
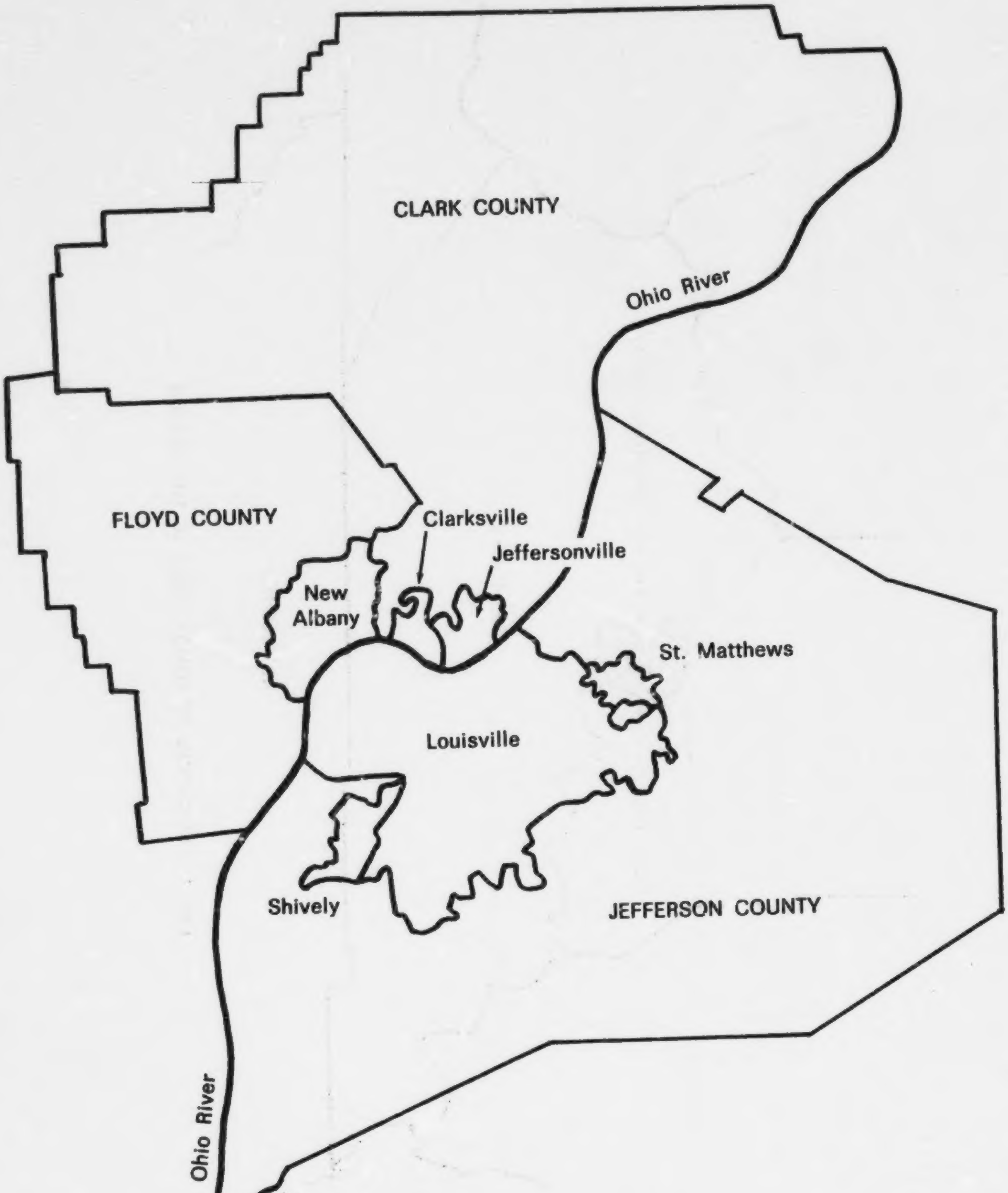

ILLINOIS
INDIANA
OHIO
Clark County
Floyd County
Jefferson County
KENTUCKY
TENNESSEE

FIG. 1—LOCATION OF STUDY AREA IN THE REGION


CLARK COUNTY
Ohio River
FLOYD COUNTY
Clarksville
Jeffersonville
New Albany
St. Matthews
Louisville
Shively
JEFFERSON COUNTY
Ohio River

LOUISVILLE STANDARD METROPOLITAN STATISTICAL AREA

FIG. 2

TABLE 2 . INCORPORATED AREAS OF JEFFERSON COUNTY

Major Cities (Population over 5000)

Louisville	389,044
Shively	18,180
St. Matthews	10,796
Jeffersontown	5,055

Smaller Cities (Population Under 5000)

Anchorage	1369	Houston Acre	741	Richlawn	657
Audubon Park	1912	Hurstbourne Acres	422	Robinswood	250
Barbourmeade	160	Indian Hills	650	Rolling Fields	821
Beechwood Village	1916	Indian Hills Cherokee	512	Rollings Hills	n.a.
Bellemeade	637	Keeneland	590	St. Regis Park	1140
Bellewood	430	Kinsley	503	Seneca Gardens	930
Blue Ridge Manor	300	Lincolnshire	221	South Park View	317
Briarwood	414	Lyndon	700	Springlee	681
Broadfields	487	Lynnview	1635	Strathmoor Gardens	331
Brownsboro Farm	375	Maryhill Estates	256	Strathmoor Manor	419
Brownsboro Village	567	Meadowview Estates	144	Strathmoor Village	491
Cambridge	280	Minor Lane Heights	1053	Wellington	831
Cherrywood Village	691	Mockingbird Valley	203	West Buechel	539
Devondale	1364	Moorland	651	Wildwood	475
Druid Hills	438	Norbourne Estates	573	Windy Hills	336
Fairmead	364	Northfield	322	Woodland Hills	1373
Forest Hills	450	Parkside	307	Woodlawn Park	769
Glenview Manor	185	Parkway Village	910		1327
Graymoor	1494	Plantation	939		
Hollyvilla	350	Plymouth Village	292	TOTAL	37,497

3. Business and Industry

Jefferson County accounts for 93% of the SMSA non-agriculture employment and has a total work force of some 234,000 distributed as shown in Table 3 .

TABLE 3 .

METROPOLITAN EMPLOYMENT - LOUISVILLE AREA

	Goods Producing	Services Producing	Total
Jefferson County	90,283	143,741	234,024
Clark County	5,706	3,339	9,045
Floyd County	4,761	3,570	8,331
Total SMSA	100,750	150,650	251,400

Manufacturing accounts for an increasing share of the total employment, having grown from 25% in 1940 to more than one-third of the total in 1964. The manufacturing sector is widely diversified: machinery, lumber and furniture, tobacco, liquor, chemiclas, automibles, appliances, and food production are important components of manufacturing. The Louisville Metropolitan area exported 131 million dollars of manufactured goods in 1966 and had an estimated 1968 value added by manufacture of 2.4 billion dollars.

II-B. Estimated Growth of Area

1. Population

Louisville and Jefferson County are expected to experience rapid growth over the next three decades. The population of the county is expected to increase from 670,000 in 1967 to 1,105,000 by the year 1990 as shown in Table 4 and Figure 3 . It should be emphasized that almost all this growth will take place outside the city of Louisville. As a result it is expected that almost all vacant land in Jefferson County will be occupied by the turn of the century. The effect of this anticipated growth on land-use patterns within Jefferson County is shown in Figures 4 and 5 .

2. Business and Industry

Output projections for the metropolitan area indicate a tenfold increase in manufacturing and a twofold increase in wholesale trade by 1990 over current output levels. During the same period retail trade output is expected to increase from a 1967 value of 1.37 billion dollars to an estimated 3 billion dollars. This growth will result in substantial increase in the labor force from present level of 240,000 to an estimated 380,000 by 1990 as shown in Figure 6 . A complete breakdown of employment projections, by employment groups, is shown in Table 5 .

TABLE 4

DISTRIBUTION OF POPULATION

METROPOLITAN LOUISVILLE 1965-1990

	1965	1970	1975
Louisville City	392,700	392,700	402,400
Rest of Jefferson County	269,500	326,000	415,200
Sub-Total	(662,200)	(718,700)	(817,600)
Clark County	69,000	75,200	84,400
Floyd County	53,700	61,500	69,000
TOTAL	784,900	855,400	971,000

	1980	1985	1990
Louisville City	412,200	412,200	412,200
Rest of Jefferson County	504,400	598,700	693,000
Sub-Total	(916,600)	(1,010,900)	(1,105,200)
Clark County	94,700	106,000	118,100
Floyd County	76,700	85,900	96,000
TOTAL	1,088,000	1,202,800	1,319,300

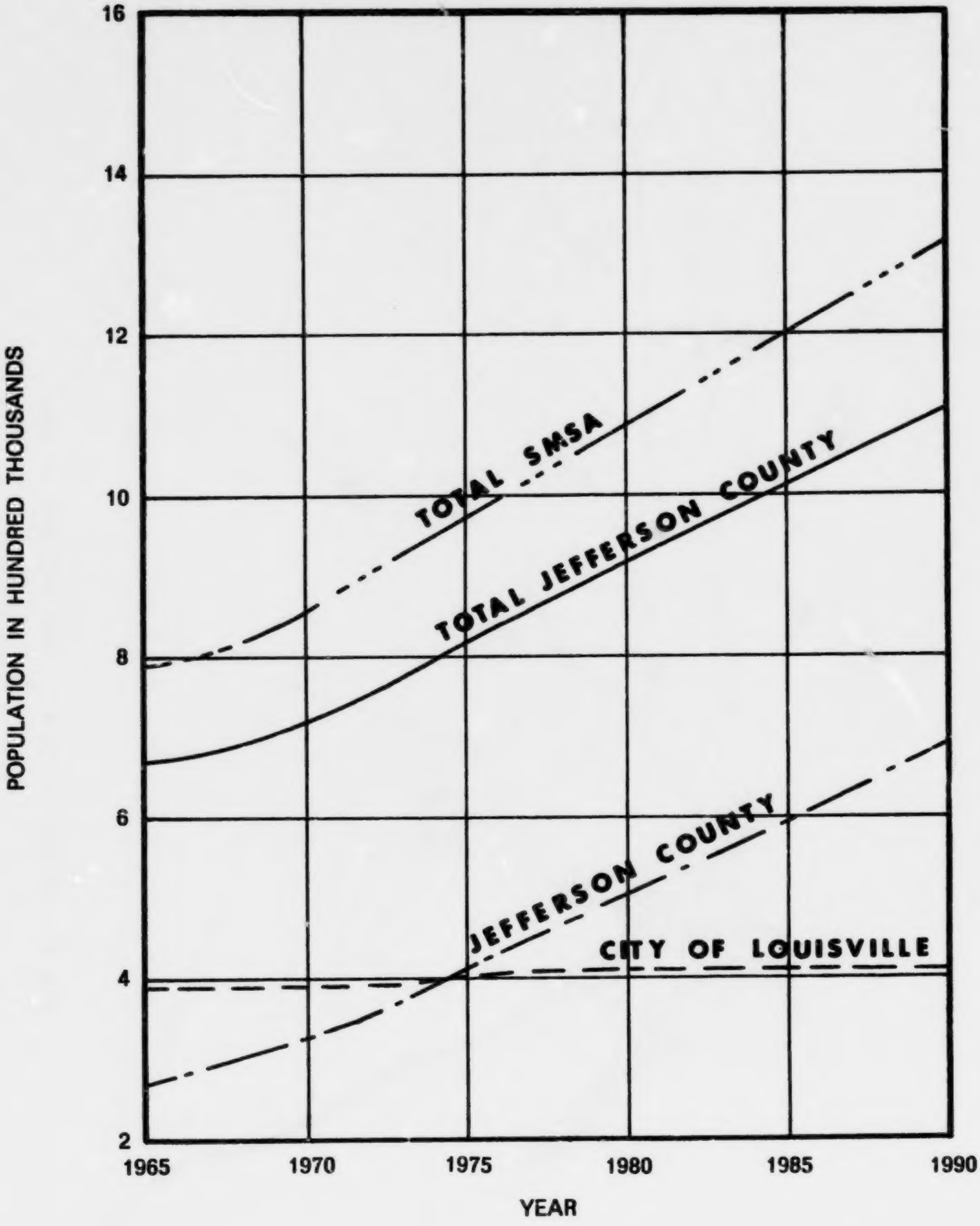


FIG. 3 — JEFFERSON COUNTY

POPULATION PROJECTIONS: 1965-1990

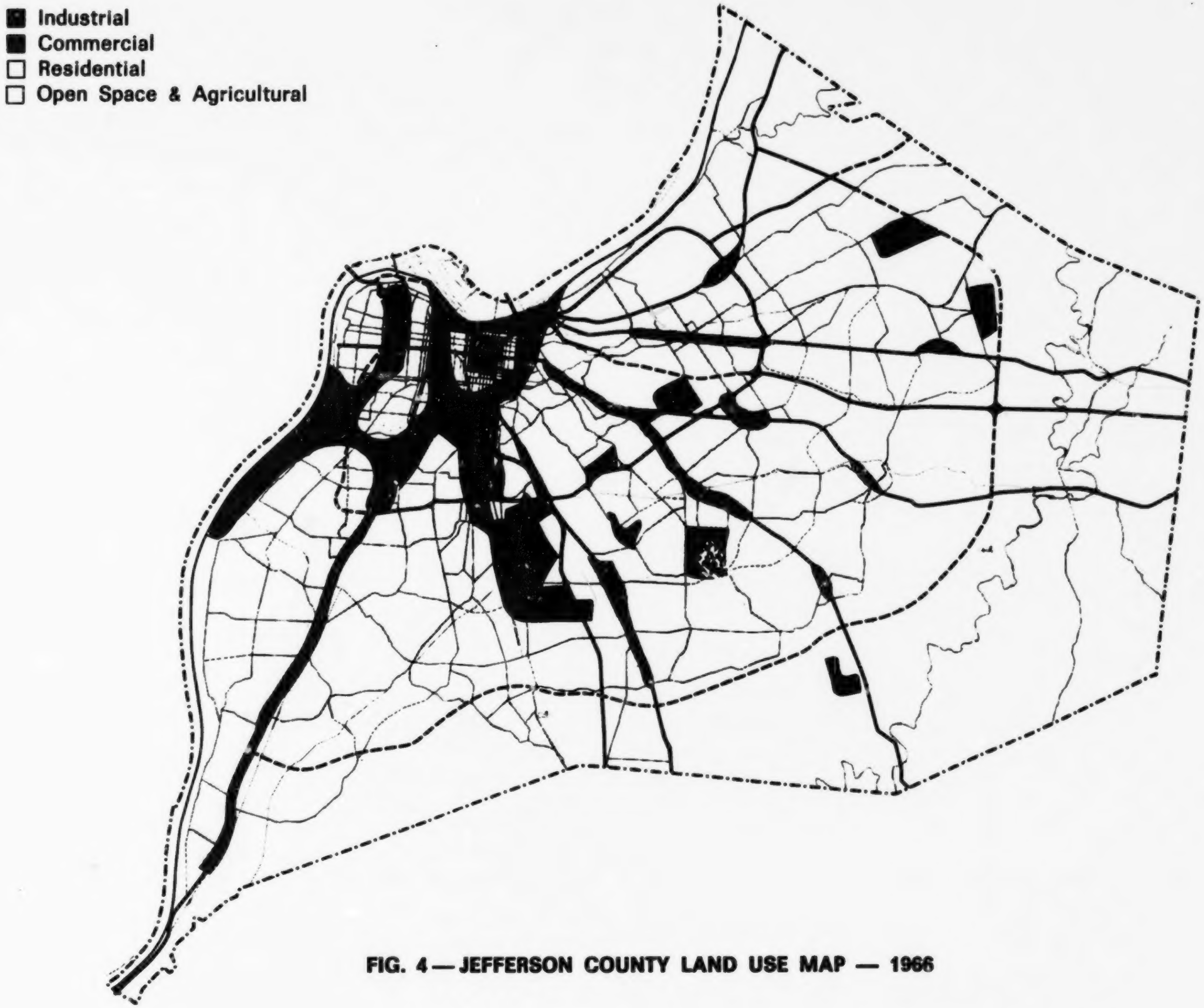

■ Industrial
■ Commercial
☐ Residential
☐ Open Space & Agricultural

FIG. 4 — JEFFERSON COUNTY LAND USE MAP — 1966

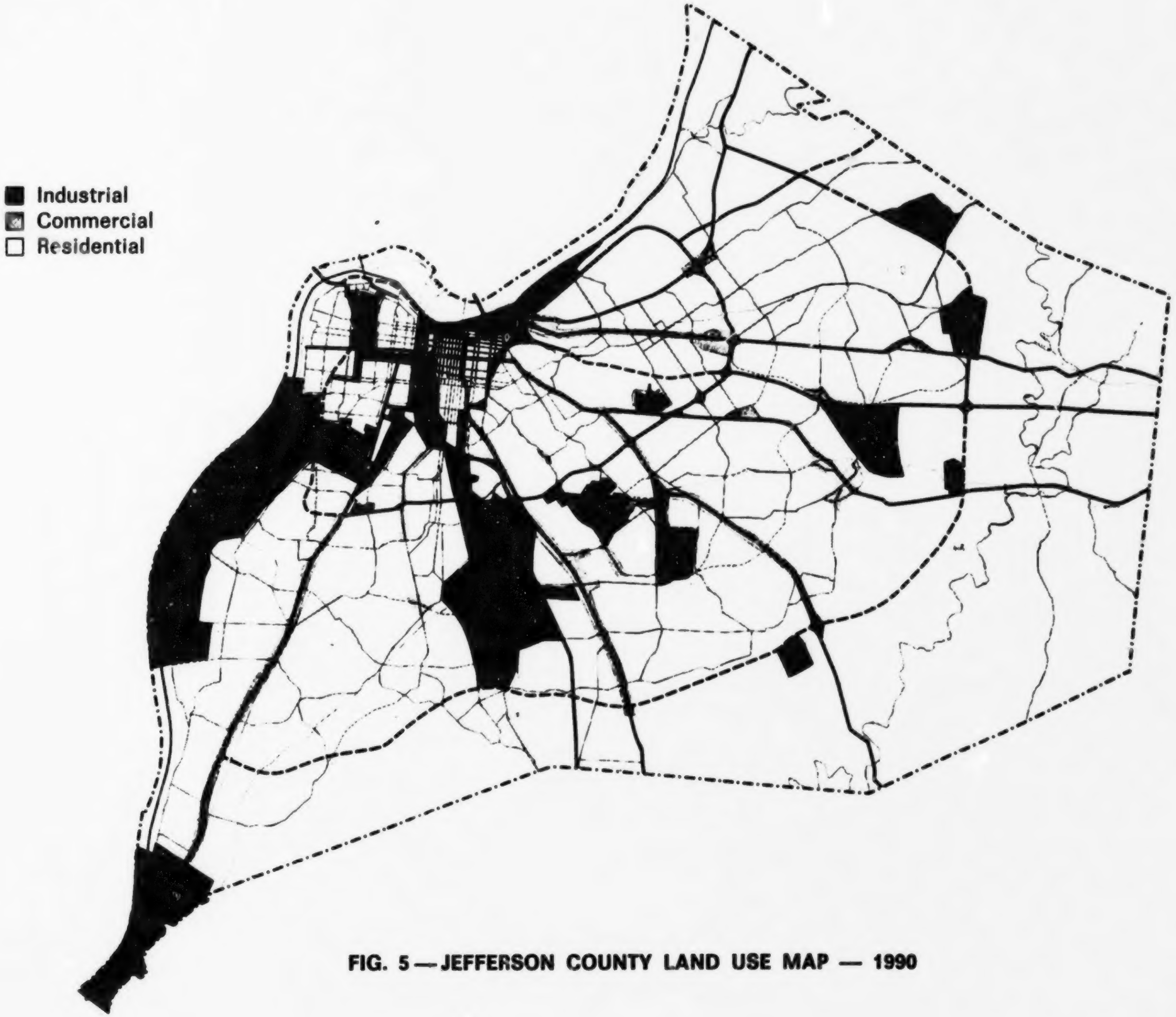

■ Industrial
▨ Commercial
☐ Residential

FIG. 5 — JEFFERSON COUNTY LAND USE MAP — 1990

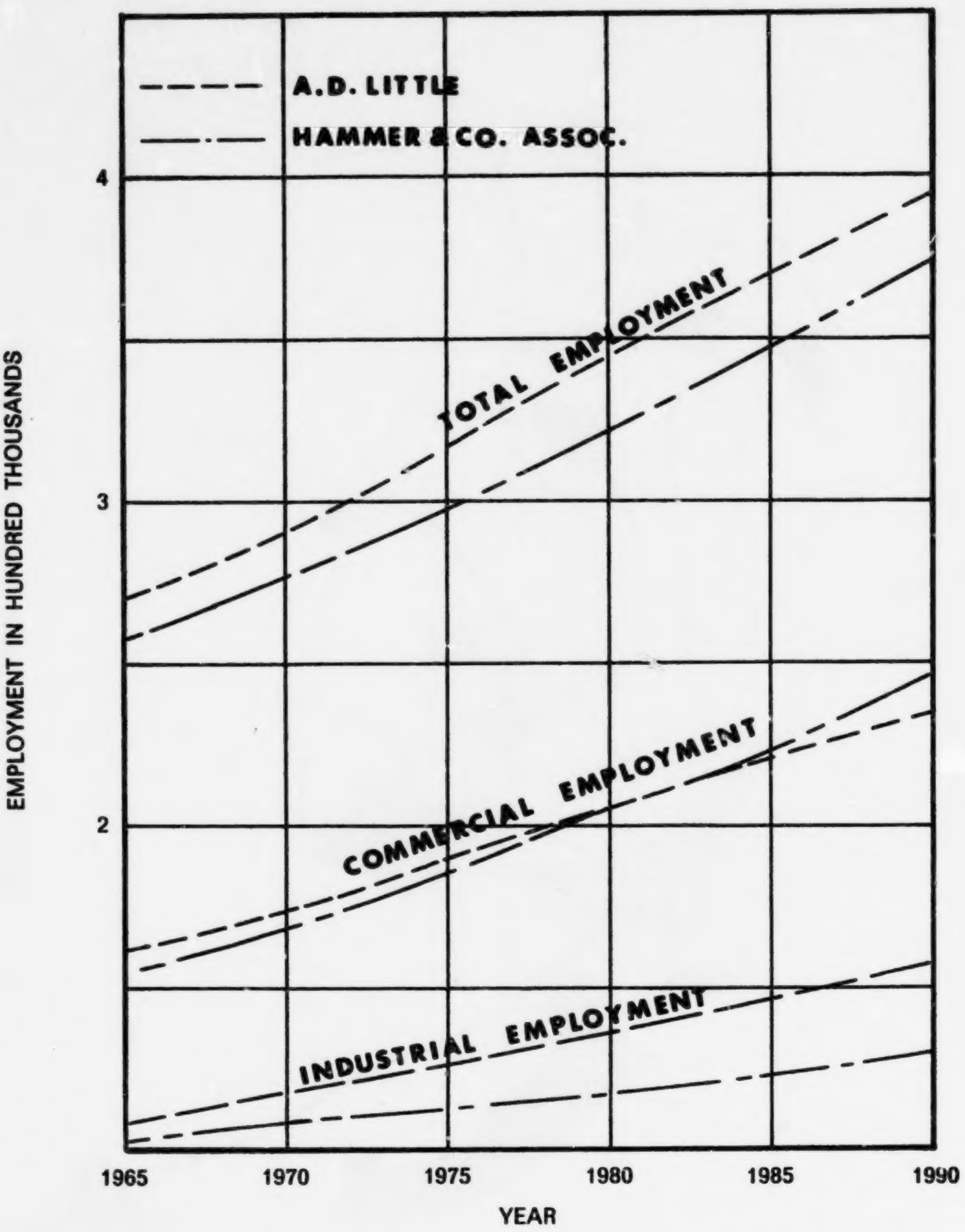


FIG. 6 — JEFFERSON COUNTY

EMPLOYMENT PROJECTIONS: 1965-1990

TABLE 5. EMPLOYMENT PROJECTIONS - METROPOLITAN LOUISVILLE (1965-1990)

	1965	1970	1975	1980	1985	1990
Goods-Producing						
Manufacturing	89,000	91,500	96,250	101,000	106,300	111,600
Construction	13,400	14,600	16,200	17,700	19,400	21,200
Mining	300	300	300	300	300	200
Sub-Total	(102,700)	(106,400)	(112,750)	(119,000)	(126,000)	(133,000)
Services-Producing						
Trade:						
Wholesale	17,300	17,500	17,700	18,400	18,800	19,200
Retail	38,300	44,300	49,550	54,300	59,400	64,500
Sub-Total	(55,600)	(61,800)	(67,250)	(72,700)	(78,200)	(83,700)
TCU 1/	20,500	20,600	20,900	21,200	21,750	22,300
FIRE 2/	13,500	16,500	18,100	19,700	20,900	22,100
Services	36,600	41,800	46,950	52,100	55,950	59,800
Government	28,100	32,900	38,650	44,400	50,100	55,800
Sub-Total	(154,300)	(173,500)	(191,850)	(210,100)	(226,900)	(243,700)
TOTAL	257,000	280,000	304,600	329,100	352,900	376,700

1/ Transportation, Communications, and Utilities

2/ Finance, Insurance and Real Estate

II-C. Current Status of Solid Waste Collection and Disposal in Jefferson County

A brief description of collection and disposal practices currently prevailing in Jefferson County follows. Figure 7, showing the location of all major disposal sites is provided for reference.

1. Domestic Waste

a. Definition - Domestic waste includes refuse, rubbish and garbage resulting from the operation and maintenance of a household. The garbage fraction of residential waste is defined more specifically as the putrescrible waste resulting from the preparation, cooking and consumption of edible foodstuffs. Rubbish is defined as those wastes, generally not subject to periodic collection, that are removed by either the householder, or by a collection agency at the request of the householder, usually at an extra fee.

b. Collection - Because residential waste contains putrescible materials, and therefore presents a potentially serious health hazard, such wastes are subject to regularly scheduled collection by a sanitation agency. Within Jefferson County four cities, Louisville, Shively, Jeffersontown, and Audubon Park maintain and operate their own collection force. The remaining 59 fourth-, fifth- and sixth-class cities, and the unincorporated areas of the county, rely on private refuse collectors for the removal of residential wastes.

There are twelve major privately owned refuse collection agencies operating in Jefferson County. There are also

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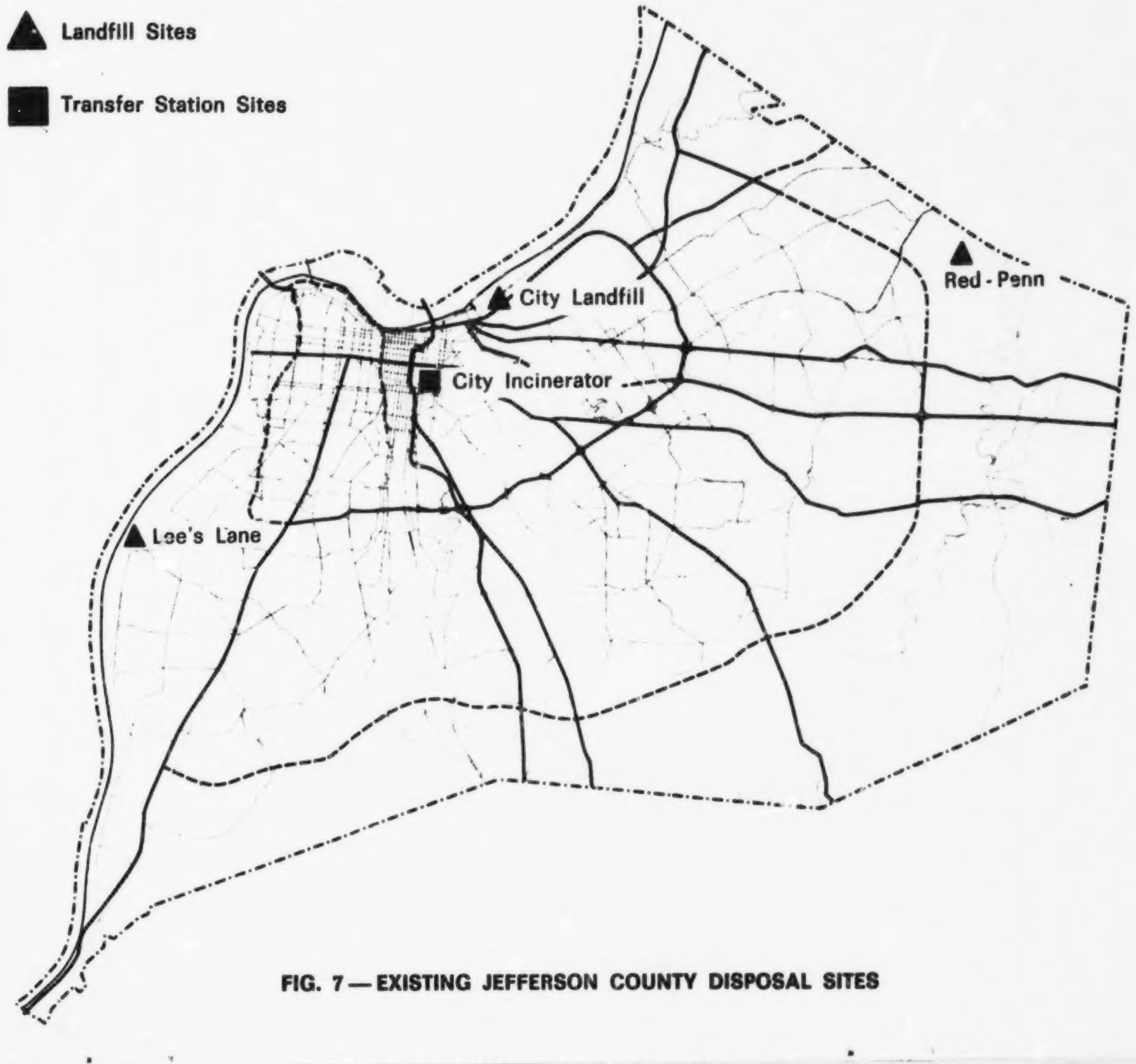


▲ Landfill Sites
■ Transfer Station Sites
City Landfill
Red - Penn
City Incinerator
Lee's Lane

FIG. 7 — EXISTING JEFFERSON COUNTY DISPOSAL SITES

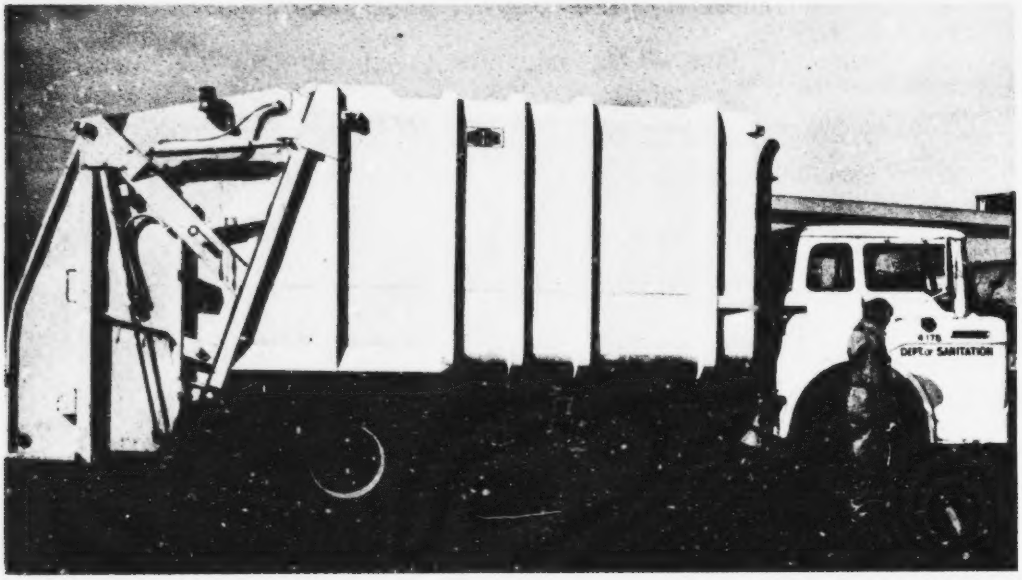
number of minor collectors operating in the county. Some of these collect on a scheduled basis, but the majority deal with rubbish removal on a "will-call" basis. The minor collectors handle a very small percentage of the total waste volume generated in Jefferson County.

All municipal and major private collectors, and most of the minor collectors dealing in putrecible refuse, operate packer-type, closed refuse collection vehicles similar to the one shown in Figure 8. The crew size is generally one driver and two tippers. Collection frequency is twice a week throughout the county with only a few minor exceptions.

Curb-side pick-up is practiced in Louisville, Shively, Jeffersontown, and most of southern and southwestern Jefferson County. In Audubon Park and most of eastern and southeastern Jefferson County, the collectors pick up the refuse containers from the back yard or garage area, carry them to the collection vehicle for emptying and return the cans to the rear of the premises. In some cases, the collectors transfer the refuse from garbage cans into larger 40-50 gallon containers carried by the tipper. This technique often permits servicing more than one residence before it is necessary for the tipper to return to the truck.

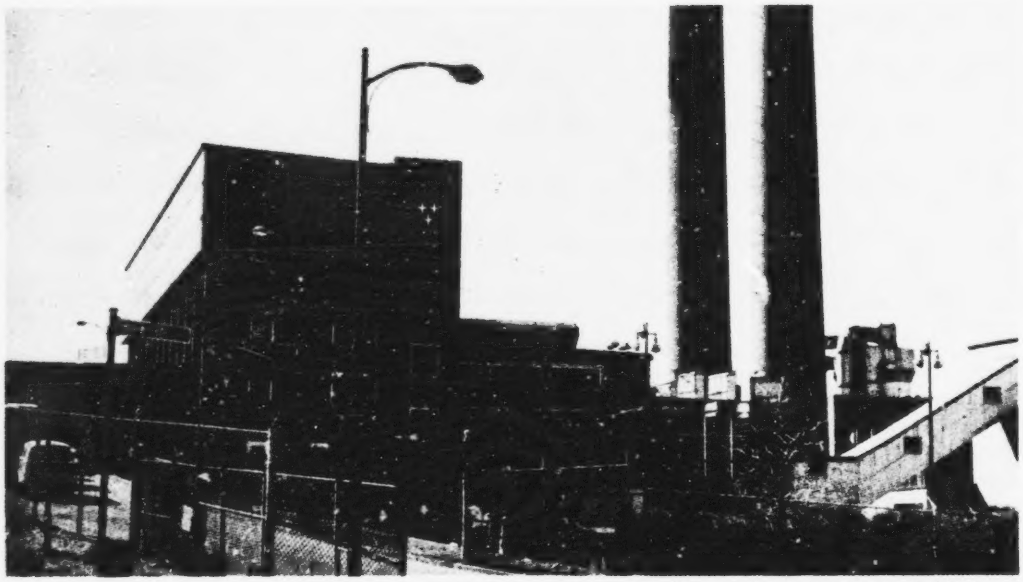
c. Disposal - All residential wastes collected by the city of Louisville are disposed of at the city owned incinerator at 636 Meriwether Street (Figure 9).

Residential wastes from Shively, and southern and southwestern Jefferson County, are taken to a privately owned


4178
DEPT OF SANITATION

Courtesy of Louisville Department of Sanitation

FIG. 8 — TYPICAL RESIDENTIAL COLLECTION VEHICLE



Courtesy of Louisville Department of Sanitation

FIG. 9 — LOUISVILLE INCINERATOR

landfill on Lee's Lane in the western part of the county. Some wastes from the southeastern areas of the county are also taken to this landfill, in spite of the long haul distances involved.

Most refuse from southeastern and eastern Jefferson County are taken to the privately owned landfill located on Ash Avenue, just across the county line in Oldham County. The future of this disposal site is clouded by the fact that it is the only sanctioned landfill still in operation outside Jefferson County.

d. Costs - Collection and disposal costs vary widely throughout the county. The costs for the city of Louisville, including disposal, are approximately $13 per ton of refuse. The average fifth- and sixth-class city pays approximately $16 per ton for refuse collections and disposal. Costs for individual homeowners in the unincorporated areas of the county average $3.50 per household per month, with the actual price depending upon whether pick-up is curbside or rear door.

The higher average costs reported for the fifth- and sixth-class cities is attributable primarily to the fact that most of these communities have rear door pick-up, and often have a very small number of services per mile. In general, the lower the population density, the higher the unit collection costs. A summary of residential waste collection and disposal costs is given in Table 6 .

TABLE 6 DISPOSAL COSTS FOR 5th and 6th CLASS CITIES

Name of city	Population	Ton/ yr.	Cost/ ton
Audubon Park	1912	1703	22.12
Bellemeade	637	305	14.18
Bellewood	430	206	21.45
Briarwood	414	198	13.70
Broadfields	487	251	13.73
Brownsboro Village	567	271	19.25
Cambridge	280	134	12.91
Cherrywood Village	691	356	13.15
Devondale	1364	678	13.22
Druid Hills	438	226	22.30
Fairmeade	364	188	22.43
Graymoor	1494	743	11.70
Houston Acres	741	354	16.77
Indian Hills	650	360	15.77
Indian Hills, Cherokee Section	512	312	26.34
Keeneland	590	287	14.92
Kingsley	503	231	22.73
Lydon	700	335	12.98
Meadowview Estates	144	73	25.32
Minor Lane Heights	1053	424	8.09
Moorland	651	311	20.24
Norbourne Estates	573	296	24.86
Parkside	307	158	21.04
Parkway Village	910	384	14.46
Plantation	939	484	18.30
Plymouth Village	292	145	24.19
Richlawn	657	339	9.16
Rolling Fields	821	424	21.50
St. Regis Park	1140	545	17.34
Seneca Gardens	930	462	16.46
Springlee	681	326	18.90
Strathmoor Gardens	331	164	23.16
Strathmoor Manor	419	232	16.06
Strathmoor Village	491	253	21.34
Wellington	831	426	14.57
West Buechel	539	237	13.97
Wingy Hills	1372	708	6.53
Woodlawn Park	1327	685	8.42
The average cost per ton			=$16.15

2. Commercial Wastes

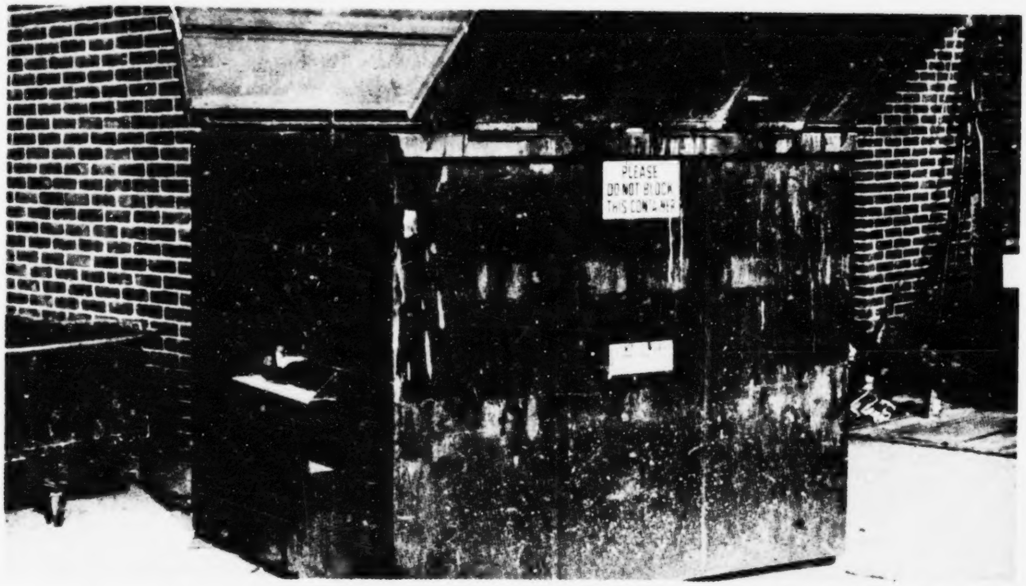
a. Definition - Commercial wastes are defined as all waste materials resulting from the operation of business or commercial establishments. These wastes consist of two primary components, commercial refuse, and garbage. Commercial refuse includes material other than foodstuffs and is primarily paper and cardboard packaging, miscellaneous cans, and other debris. The garbage component of commercial wastes includes cuttings and spoiled food wastes from produce markets, and solid and semi-solid putrecible wastes from food processing plants, restaurants, hotels, etc.

b. Collection - The city of Louisville provides curbside can pick-up for the smaller commercial establishments, with a limit to the number of cans picked up free of charge. The Louisville Department of Sanitation also provides containerized dumpster services to about 250 larger commercial establishments. The majority of commercial refuse in the city of Louisville, and all commercial wastes outside the Louisville city limits, are collected by private collection firms. Of the twelve major private haulers, nine collect commercial together with residential refuse; the three remaining collectors are oriented toward the larger refuse producers.

The collection agencies operate containerized collection systems of two general types. The first type container is designed for the major refuse producers. These are large "dumpster" type containers that must be removed at the collection point, taken to the place of disposal, emptied and returned to be refilled. The frequency of service depends upon the refuse production rate. A second type of service is provided those establishments producing quantities of refuse greater than that which municipalities will collect free of charge, but not enough to warrant dumpster service This method utilizes smaller containers of from 2 to 10 cubic yard capacity that can be emptied into a refuse compactor truck by various automatic devices. The frequency of collection of these containers is dependent upon the needs of the refuse producer. Typical containers used in each type of service are shown in Figures 10 and 11.

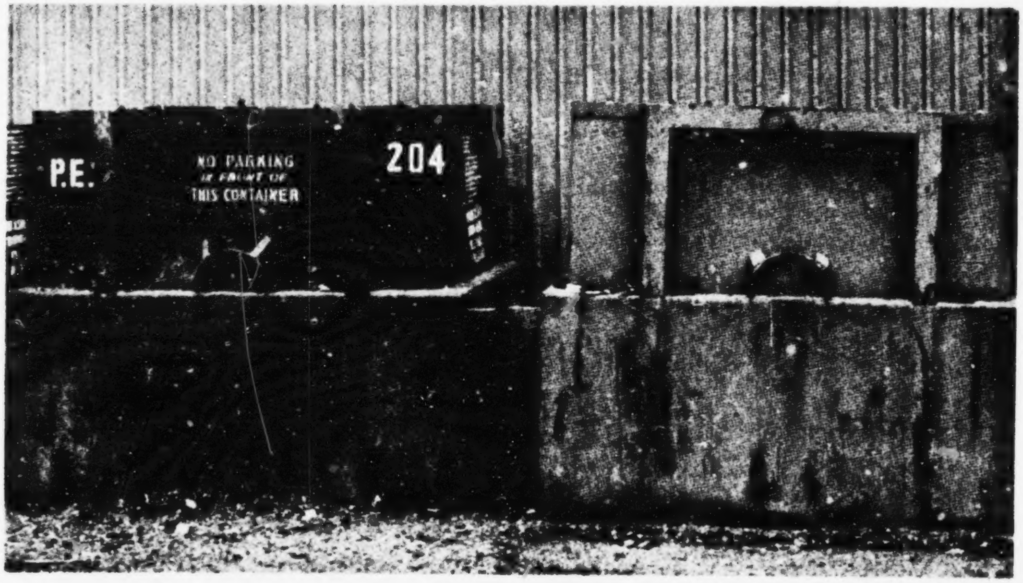
c. Disposal - All commercial wastes collected by the Louisville Department of Sanitation are burned in the city incinerator. The three major commercial haulers have been taking a large portion of their wastes to the city incinerator. A recent increase in incinerator charges is expected to divert a substantial portion of this refuse to the already overloaded Lee's Lane and Ash Avenue landfills.

One major commercial hauler owns and operates his own landfill, but is using this site for only part of his refuse volume. A conical type refuse burner was utilized at this site to reduce the volume of paper and wood wastes before placing them in the landfill. This burner has been disassembled because of general deterioration due to age, but the owner is planning to erect a new one in the immediate future.


PLEASE
DO NOT BLOCK
THIS CONTAINER

Courtesy of Valley Sanitation Co.

FIG. 10 - TYPICAL INTERMEDIATE SIZE REFUSE CONTAINER (2-10 cu. yd.)


P.E.
NO PARKING
IN FRONT OF
THIS CONTAINER
204

Courtesy of Industrial Service of America

FIG. 11 - TYPICAL LARGE SIZE "DUMPSTER" CONTAINER (more than 10 yds.)

d. Costs - Collection costs for commercial service are generally lower than those for residential collection because of the reduced labor requirements, made possible through the use of containerized pick-up systems. Costs for the city Sanitation Department dumpster service are $6.20 per ton, excluding disposal costs. Inasmuch as private commercial collection is highly competitive, costs were not available, but should be similar to those of the city, with the small containerized service costing slightly more than the high volume dumpster service.

3. Industrial Wastes

a. Definition - Industrial refuse includes all solid wastes produced by the manufacturing industries for which there is no apparent production value. Although the broad term, industrial wastes, may also include gaseous and liquid wastes, such materials are excluded from this report, except those cases where vessels containing gaseous or liquid wastes are disposed of at a solid waste disposal facility. The terms industrial wastes and industrial refuse are used interchangeably in this report.

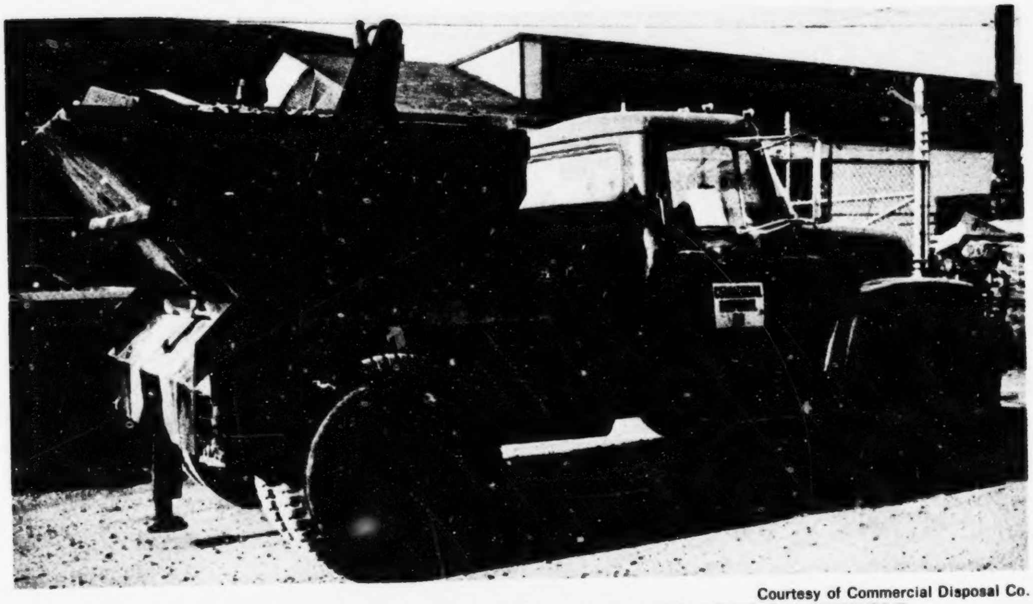
b. Collection - The Louisville Department of Sanitation handles a very small quantity of industrial wastes, and virtually all industrial refuse collected by private haulers is handled by four major haulers.

Because of the varied nature of the wastes encountered, several types of vehicles are used in the collection of industrial wastes. Although the dumpster and front-end loading containerized systems are predominate, open-dump and stake trucks are widely used for large, bulky items such as packing crates, pallets, empty metal drums, etc. Specialized equipment is often required for foundry sand, slag, and other hard to handle materials. An example of such specialized equipment is shown in Figure 12. The use of high-capacity, stationary compactor units, similar in concept to the dumpster-type container, but with the added features of equipment capable of compacting the refuse to high densities on site, before removal by the hauler, can substantially reduce the number of pick-ups that must be made to the container site. An example of such a unit is shown in Figure 13.

*Note: Stationary compaction units can also be used to collect high volume commercial wastes, and have been used for residential wastes in high rise apartment complexes.

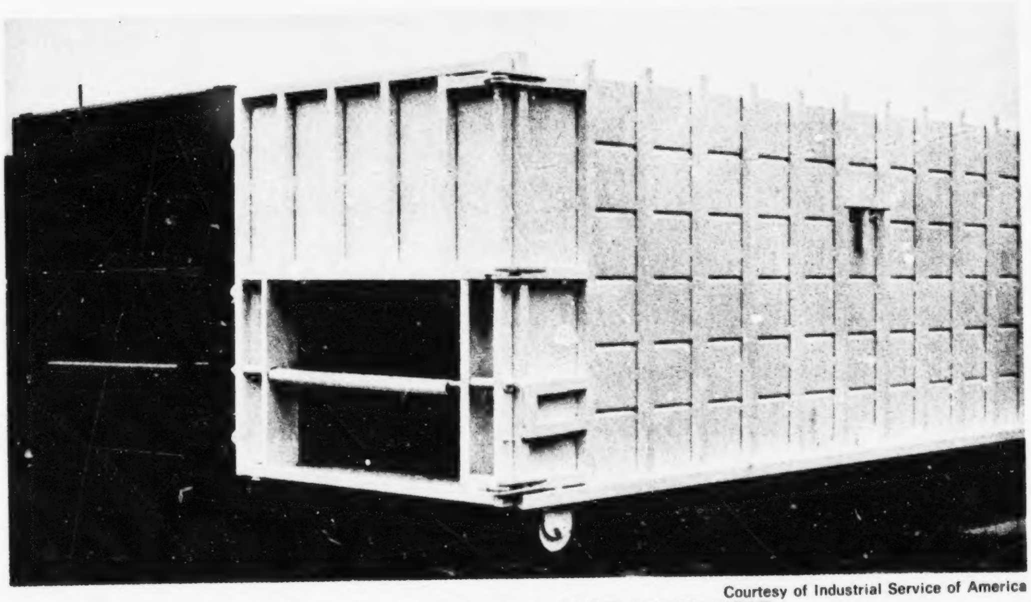
c. Disposal - Almost all of the estimated 600 tons of industrial refuse collected daily by private haulers is disposed of at either the Meriwether incinerator plant or at the Lee's Lane landfill. About 60 tons per day is disposed of by Commercial Disposal Company, Inc. at their Minor's Lane landfill site. Industrial Services of American disposes of a large portion of the wastes collected by them at their new Grade Lane landfill site.

The Lee's Lane site also receives a large portion of the estimated 325 tons per day of refuse disposed of by industries using their own equipment and employees. However, a substantial amount of this material is presently being disposed of by many



Courtesy of Commercial Disposal Co.

FIG. 12 — SPECIALIZED INDUSTRIAL WASTE COLLECTION VEHICLE



Courtesy of Industrial Service of America

FIG. 13 — STATIONARY COMPACTOR UNIT

firms on their own property. Wastes such as wood and paper are often incinerated, on site, in small industrial type burners. Pending air pollution legislation makes the future of such incineration devices uncertain. Three of the larger industries in Jefferson County operate landfills on company property and do not utilize public or private disposal facilities. These firms, DuPont, General Electric, and the L & N Railroad, produce substantial quantities of refuse. Termination of these disposal operations would aggravate an already serious situation.

4. Municipal Wastes

a. Definition - Municipal refuse includes sweepings and wastes resulting from park and street maintenance, dead animals, wastes generated by schools, hospitals and libraries, sewage sludge, and incinerator residue.

b. Collection - Almost all of the municipal refuse generated in Jefferson County originates in the city of Louisville. Other incorporated areas of the county do not perform services such as street cleaning and dead animal pick-up. The Louisville Department of Sanitation services more than 200 dumpster contracts free of charge to city schools, hospitals, libraries, and certain non-profit charitable institutions. County schools contract for refuse removal individually with private collectors; most have dumpster type services.

The Louisville Department of Sanitation collects all dead animals within the city limits. Dead animal pick-up in this county is handled by the Humane Society and the State Highway Department.

The Metropolitan Sewer District collects and hauls all refuse resulting from its operations using MSD equipment and personnel.

Incinerator residue is collected by a private hauler under contract to the city.

c. Disposal - Sewage sludge from the MSD owned treatment plant at Fort Southworth in western Jefferson County is taken to a nearby sandpit on Camp Ground Road. Incinerator residue is usually taken to the city owned landfill on Ohio Street, but on occasion has been used at selected fills by request. Dead animals are taken to a local rendering company; those unfit for disposition in this manner are buried at the Ohio Street landfill. Wastes from Louisville city parks and street sweepings are also taken to the Ohio Street landfill. All other Louisville municipal wastes are incinerated in the Meriwether plant. Any wastes of this type generated outside the Louisville city limits are taken to either the Lee's Lane or the Ash Avenue landfills, with a small amount being hauled to the Louisville incinerator.

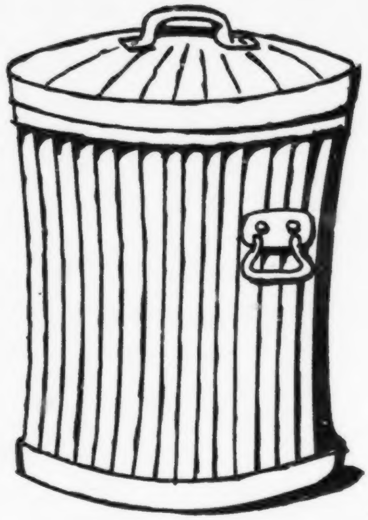
5. Construction and Demolition Wastes

a. Definition - Construction and demolition wastes are debris resulting from urban renewal projects, land clearing, building wreckage, and all types of new construction or renovation. Such wastes generally consist of broken masonery, wood fragments, roofing materials, insulation, glass, and some wire and piping. These materials are very dense individually but often combine in aggregate to form a loose structure with a high volume of voids.

b. Collection - The majority of all construction and demolition wastes are handled by the individual construction or wrecking companies, although the private haulers have made substantial progress in marketing containerized refuse removal service to construction sites.

c. Disposal - Because such wastes rarely contain putrecible or toxic materials, they do not present a direct health hazard or nuisance to the public, and therefore have not been subject to the same degree of control as other types of refuse. Although some of these materials are taken to the major landfills, a substantial portion is hauled onto private property and used to fill in a low spot or sink-hole. Because of the wide use of these small scattered disposal points, it is impossible to get a clear picture of disposal practices. There is one major landfill site, located at 39th Street and Gibson Lane in the west end of Louisville, that was used by local urban renewal contractors. This site has been filled to capacity and is now closed.

PART III: REFUSE QUANTITIES AND COMPOSITION



III. REFUSE QUANTITIES AND COMPOSITION

III-A. General

1. Unit Refuse Generation Values

In order to develop a realistic approach to current and future refuse disposal requirements it was necessary to determine the quantities and characteristics of refuse now being generated and to estimate the amounts of refuse expected in the future. The unavailability of useful information on refuse quantities and composition required an extensive data gathering program to collect such data for domestic, commercial, industrial, municipal and construction and demolition wastes.

This information was also required to determine the most advantageous locations of future refuse disposal facilities. The refuse generated by a metropolitan area is distributed unevenly through the area. A predominately industrial or commercial area, with a small residential population, may produce a far greater quantity of refuse than the average suburban residential area. To develop a disposal system that is as close to optimum as possible, it was necessary to define the refuse production of the region in a way which would clearly indicate this condition. In view of this an attempt was made to represent refuse quantities in terms of some unit quantity. Although commercial and industrial refuse would be better represented by some ratio of refuse quantity to dollar volume of sales or production output, the competitive nature of most private business made it impossible to obtain accurate information on sales or output volume. Accordingly, the following unit refuse generation values were selected for use and a research program was designed to collect data which would permit their determination:

1. Domestic Refuse - pounds per capita per day
2. Commercial & Industrial Refuse - pounds per employee per day
3. Other Sources of Refuse* - pounds per capita per day

*(Except point sources such as sewage treatment plants)

These values, together with demographic data indicating the distribution of population and commercial and industrial employment, were used to determine the geographical distribution of solid wastes being generated in Jefferson County. When used with population, commercial and industrial growth projections these unit values yielded the quantities of refuse that can be expected in future years.

The results of the investigations into the quantities and composition of refuse generated by each major source is discussed in this section.

2. Definitions

The following definitions will be helpful in reading this chapter.

Refuse

Refuse comprises all of the solid wastes of the community except body wastes. It also includes semi-solid or wet wastes with insufficient moisture content to be free flowing. Some examples of refuse are garbage, rubbish, ashes, abandoned automobiles, street cleanings, and dead animals.

Garbage

Garbage is that refuse or waste material resulting from the preparation, cooking, and consumption of edible foodstuffs. It may also include spoiled food wastes from produce markets. Solid and semi-solid putrecible wastes from food processing establishments may also be classified as garbage.

Domestic Trash

Domestic trash is the waste material other than garbage resulting from the operation and maintenance of household, and is subject to regularly scheduled collection by a sanitation agency. Frequently, domestic trash is considered with respect to its component parts; namely, combustible and non combustible trash. Domestic trash and garbage together are often called domestic refuse.

Commercial Swill

Commercial swill includes the solid and semi-solid food wastes that result from the operation of restaurants, hotels, produce markets, etc.

Commercial Refuse

Commercial refuse includes the waste material other than foodstuffs resulting from the operation of business or commercial establishments. It consists primarily of paper and cardboard packages, cartons, miscellaneous cans, and other debris. Commercial refuse may also be classified with respect to its combustible and noncombustible constituents. Frequently the paper component is segregated and collected separately for salvage purposes. Commercial refuse is usually subject to regularly scheduled collection.

Rubbish

Rubbish is waste material or refuse that is generally not subject to periodic collection and is removed from the premises either by the householder himself or by the sanitation agency at the request of the householder, usually at an extra (additional) fee. The term usually designates all refuse material not specifically included in other classifications. Materials included in this category may be surplus yard and lawn trimmings; large pieces of crockery; broken bricks and concrete; worn out furniture, stoves, and children's toys; wooden boxes and crates; rubber tires; and large metal containers, such as 5 gallon cans, etc.

Industrial Refuse

Industrial Refuse includes all solid wastes produced by the manufacturing industries for which there is no apparent value, and which must be disposed of by either the municipality or by private contractors. Some examples are sawdust, metal stampings and shavings, textile clippings, etc.

Ashes

Ashes are the residue from the burning of coal, wood or other combustible material in homes, stores, or commercial establishments for the purpose of heating, cooking, or disposing of the combustible waste material. Ash disposal is a problem in those municipalities which employ incineration for refuse disposal.

Municipal Refuse

Municipal refuse includes sweepings and wastes resulting from park and street maintenance, and dead animals. These wastes are usually collected separately by the municipal sanitation agency.

Construction and Demolition Waste

Construction and demolition wastes are debris resulting from urban renewal projects, land clearing, building wreckage and construction, etc. They generally consist of broken masonery, wood fragments, roofing material, etc.

The following terms when used throughout the report are defined as indicated below:

Combustibles

This includes such items as paper, wood, foodstuffs, leaves, rags, and the like.

Non-combustibles

This includes such items as glass, metal, ashes, dirt, crockery, stone and the like.

Remaining Combustibles

This includes all those items listed under combustibles except foodstuffs.

Large Container

A container having a volume of 8 or more cubic yards. These containers are of such size that the entire container must be removed from the point of generation, taken to the disposal site, emptied, and returned to be refilled.

Intermediate Sized Containers

Containers of less than 8 cubic yard capacity that are collected mechanically. These containers must be emptied into the collection vehicle mechanically, but are emptied and remain at the point of generation.

Small Containers

Those containers small enough to be handled manually, including the common trash can and its variations.

III-B. Domestic Refuse

1. General

Domestic refuse comprises a substantial portion of the solid wastes produced in Jefferson County. It is of particular concern because such refuse contains much of the putrecible material which is the source of odor, insect, and rodent problems present at many disposal sites. The increase in the quantities of plastics and non-ferrous metals found in domestic refuse is another cause for concern since these materials are difficult to dispose of by conventional methods. Information concerning the characteristics and quantities of domestic refuse is an important element in the design of any refuse disposal system. Accordingly, an intensive sampling program was conducted to determine the quantity and composition of Jefferson County, Kentucky domestic refuse. The manner of conducting this phase of the study is reported in this section.

2. Data Collection

The methods used to gather domestic refuse data are described in this section.

a. Selection of Sampling Areas

A procedure for obtaining representative samples of combined refuse and rubbish was developed by Dr. John M. Bell of Purdue University under a National Institute of Health project. This procedure indicated the need for refuse sampling from a minimum of 400 people. The sample area was divided into three income levels; high, medium and low, to enable investigation of possible differences in refuse quantities generated by families in different income levels.

Housing, population, and income statistics of Jefferson County prepared by the U. S. Bureau of the Census were readily available, and were used to determine how to divide the county into income levels, along the boundaries of its census tracts, using the median annual family income as a criterion. The results of this division are shown in Table 7 .

TABLE 7

Major Income Levels of Jefferson County

(1960 Census)

Income Level	Income	Population	Persons per Household
Low	Less than $5000	168,186	3.08
Medium	$5000 to $7000	347,679	3.59
High	Greater than $7000	133,598	3.33

Direct proportional allocation of these people to the three socio-economic levels yields 104 people to be sampled in the low income level, 214 in the middle income level, and 82 in the high income level.

After the county households were divided in this manner pertinent data for each level was tabulated using the most recent Federal census data available, as shown in Table 8. Demographic data for the individual census tracts making up each level were examined to select sample tracts representative of the whole level. Major emphasis was placed on the family income and the owner occupied house value, but the other

TABLE 8

Jefferson County Demographic Statistics

	Income Level		
	Low	Medium	High
Population	168,186	347,679	133,598
Average Median Family Income	$3,997	$6,109	$8,740
Average Owner Occupied House Value	$7,325	$11,623	$18,213
Men/Women Ratio	0.888	0.941	0.896
Male:			
0-5 years	15.6	15.2	13.2
6-18 years	25.2	27.5	27.5
19-64 years	49.6	51.8	52.0
65 and over	9.6	5.5	7.3
Female:			
0-5 years	13.1	13.9	11.4
6-18 years	22.7	25.5	24.1
19-64 years	51.5	53.1	53.4
65 and over	12.7	7.5	11.1
Family Income Distribution Within Income Level Groups: (Per cent)			
Less than $3,000	24.4	6.7	4.4
$3,000 to $4,999	33.5	17.4	8.0
$5,000 to $6,999	23.8	34.0	20.6
$7,000 to $9,999	13.3	28.0	28.4
$10,000 to $14,999	4.3	10.7	22.2
$15,000 to $24,999	0.6	2.7	10.6
$25,000 and over	0.1	0.5	5.8
White Collar Worker/ Blue Collar Worker Ratio	0.510	0.796	2.964

population characteristics listed in Table 8 were also checked.

Two census tracts were selected as representative of the low socio-economic level, four tracts were selected to represent the medium level, and two tracts to represent the high level. The average characteristics of these sample census tracts are presented in Table 9 .

A total of 144 households or approximately twenty houses in each of the eight sample tracts, were selected as domestic refuse sampling points. The approximate locations of these groups of houses are shown in Figure 14. The two sample areas in the low socio-economic level are labeled L-1 and L-2; the four areas in the medium level are M-1, M-2, M-3, and M-4; the two areas in the high level are H-1 and H-2. Figures 15 through 22 show typical houses in each of the eight sample areas.

A door to door census of these houses was made to determine the total number of persons in each household. This enabled the results of the sampling to be put on a pounds per capita per day and a cubic feet per capita per day basis. The door to door survey also provided an opportunity to inform the members of each sample area of the fact that their refuse was being collected for the study and to personally ask their cooperation. The purpose of the study was carefully explained to allay any fears which might cause biased data.

A total of 642 people living in 144 households make up the sample population.

TABLE 9

Sample Census Tract Demographic Statistics

	Low	Medium	High
Population	8,119	43,082	18,498
Number of People Sampled	177	306	159
Average Median Family Income	$4,064	$6,117	$8,665
Average Owner Occupied House Value	$7,700	$11,926	$18,431
Men/Women Ratio	0.901	0.991	0.950
Age Distribution			
(Per cent)			
Male:			
0-5 years	14.8	17.5	15.4
6-18 years	22.4	30.1	28.7
19-64 years	52.8	49.3	50.1
65 and over	10.0	3.1	5.8
Female:			
0-5 years	12.8	16.3	13.0
6-18 years	20.2	28.9	26.3
19-64 years	51.6	50.9	52.3
65 and over	15.4	3.9	8.4
Family Income Distribution			
(Per cent)			
Less than $3,000	24.4	5.7	2.5
$3,000 to $4,999	32.8	17.5	6.0
$5,000 to $6,999	23.2	37.4	19.8
$7,000 to $9,999	14.0	28.8	29.5
$10,000 to $14,999	5.0	9.3	25.0
$15,000 to $24,999	0.6	0.1	11.5
$25,000 and over	0.0	0.2	5.7
White Collar Worker/ Blue Collar Worker Ratio	0.341	0.629	3.698

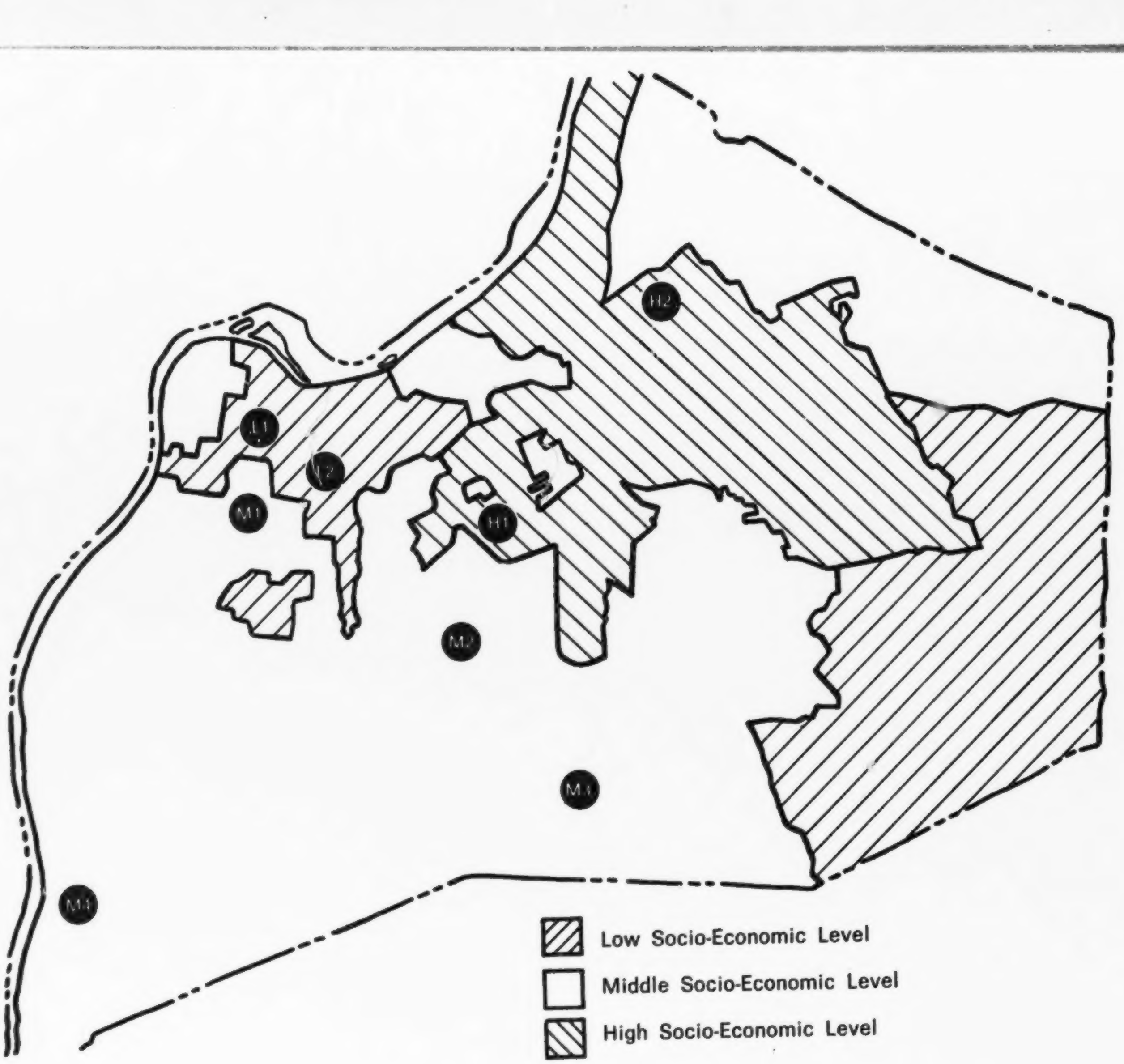

H2
L1
L2
M1
H1
M2
M3
M4
▨ Low Socio-Economic Level
☐ Middle Socio-Economic Level
▧ High Socio-Economic Level

FIG. 14

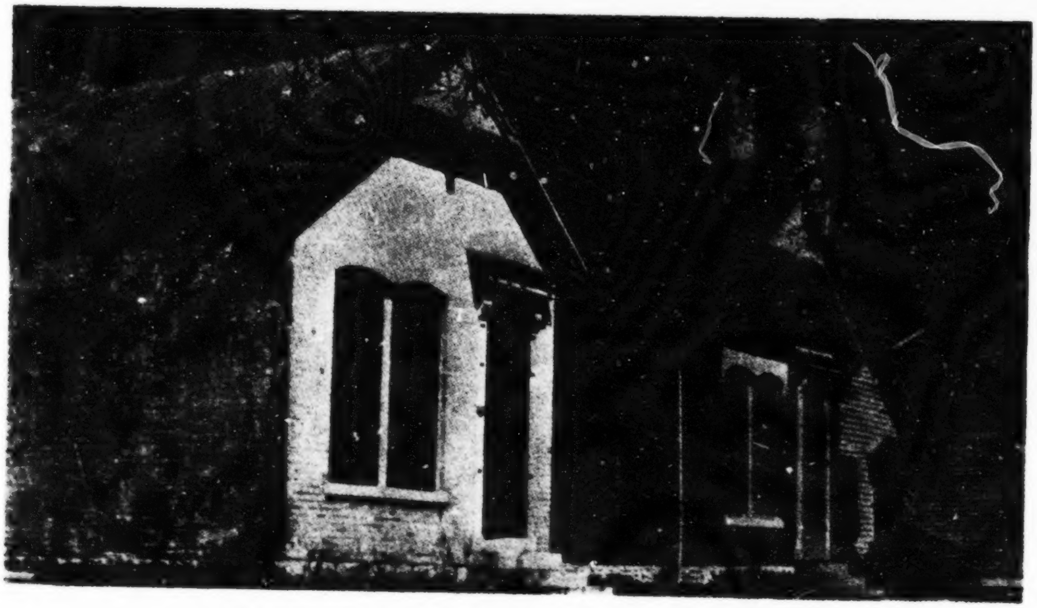


FIG. 15 — TYPICAL HOUSES IN SAMPLE AREA L-1

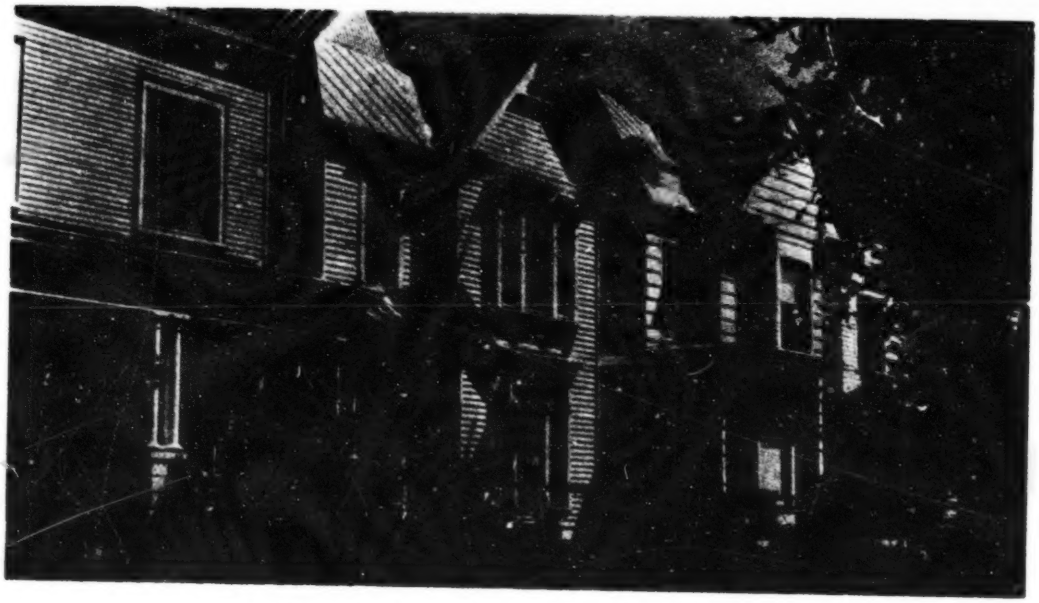


FIG. 16 — TYPICAL HOUSES IN SAMPLE AREA L-2

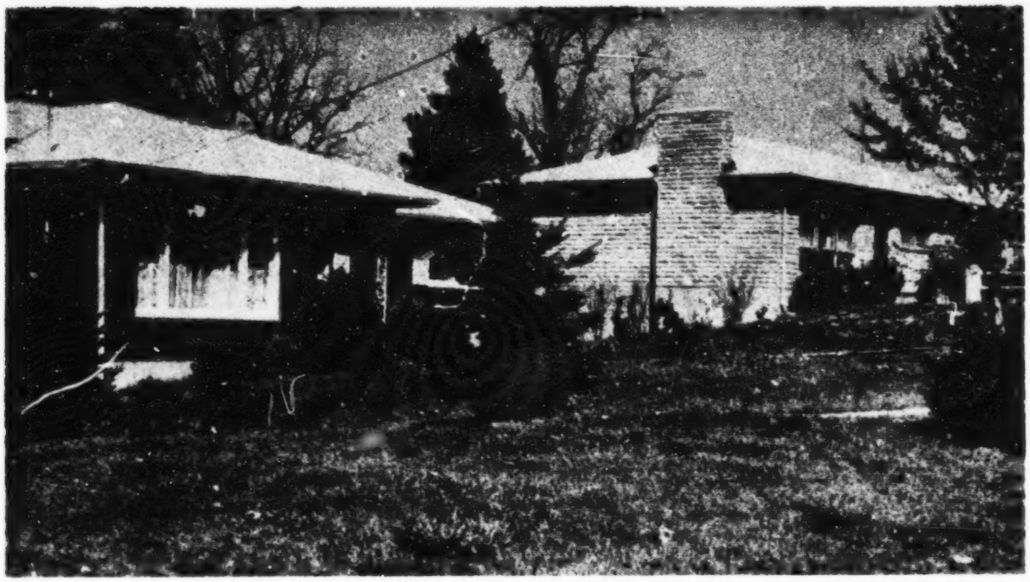


FIG. 17 — TYPICAL HOUSES IN SAMPLE AREA M-1

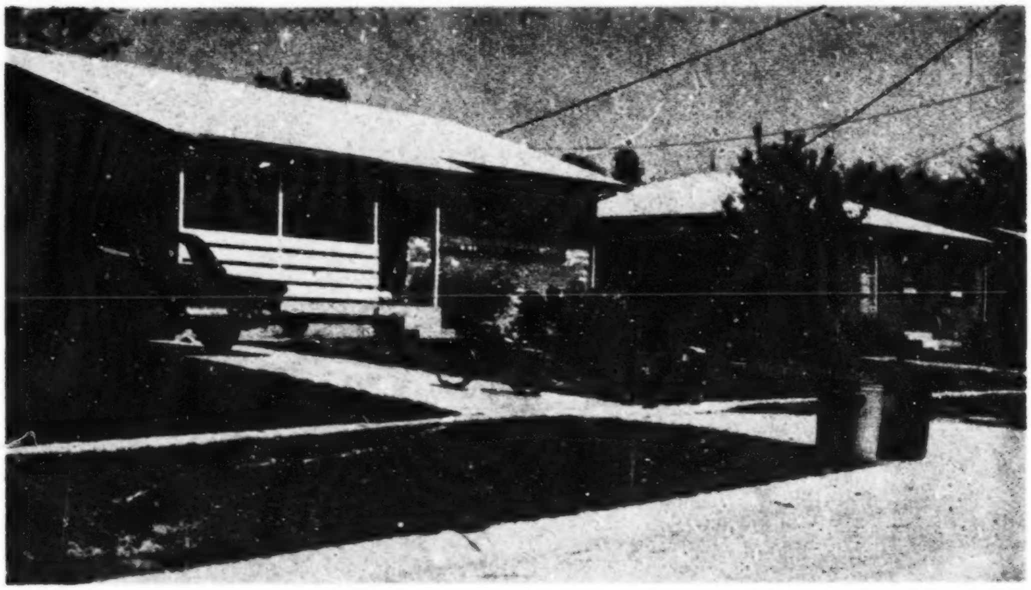


FIG. 18 — TYPICAL HOUSES IN SAMPLE AREA M-2

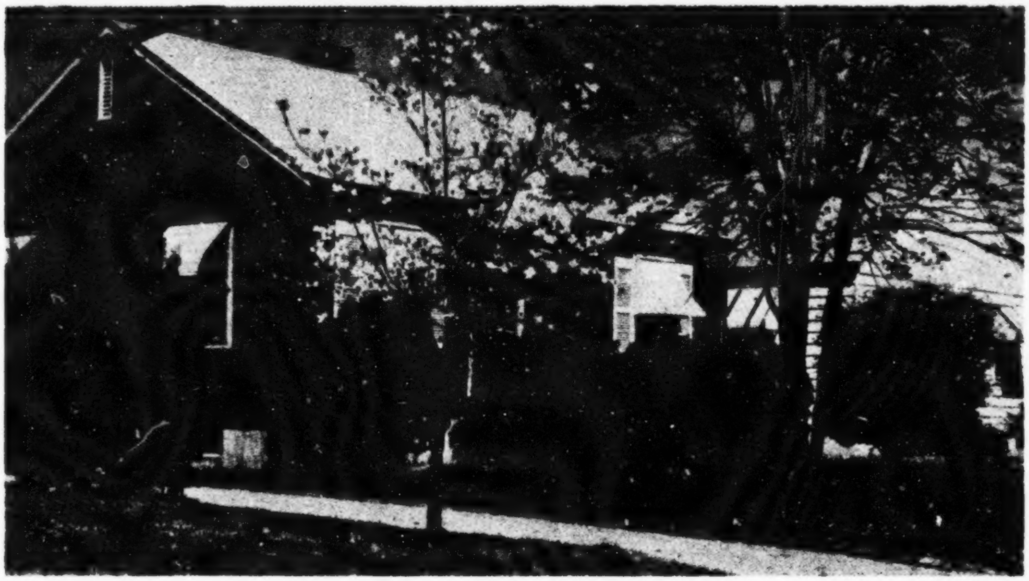


FIG. 19 — TYPICAL HOUSES IN SAMPLE AREA M-3

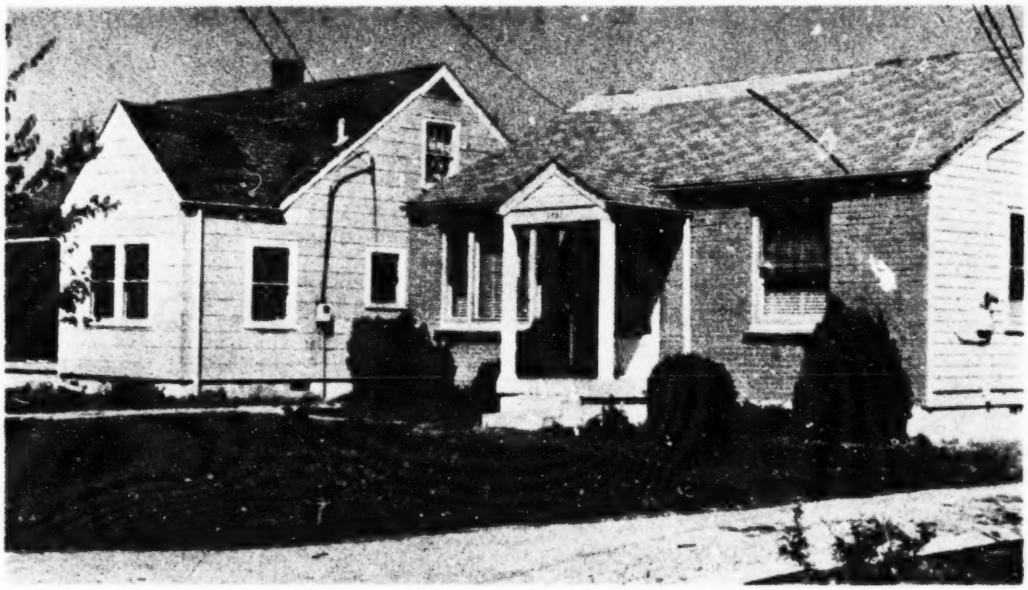


FIG. 20 — TYPICAL HOUSES IN SAMPLE AREA M-4

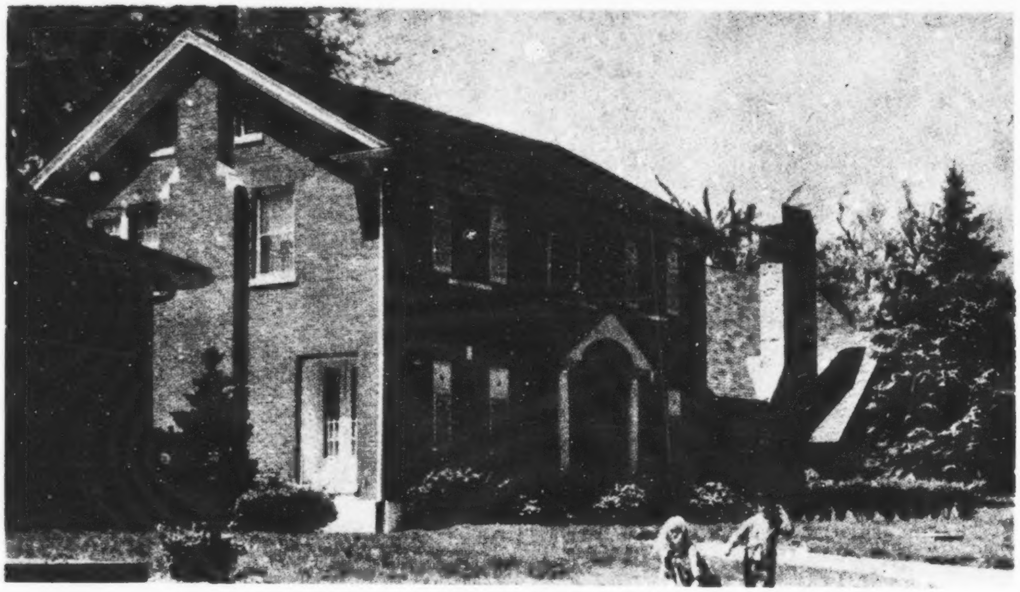


FIG. 21 — TYPICAL HOUSES IN SAMPLE AREA H-1

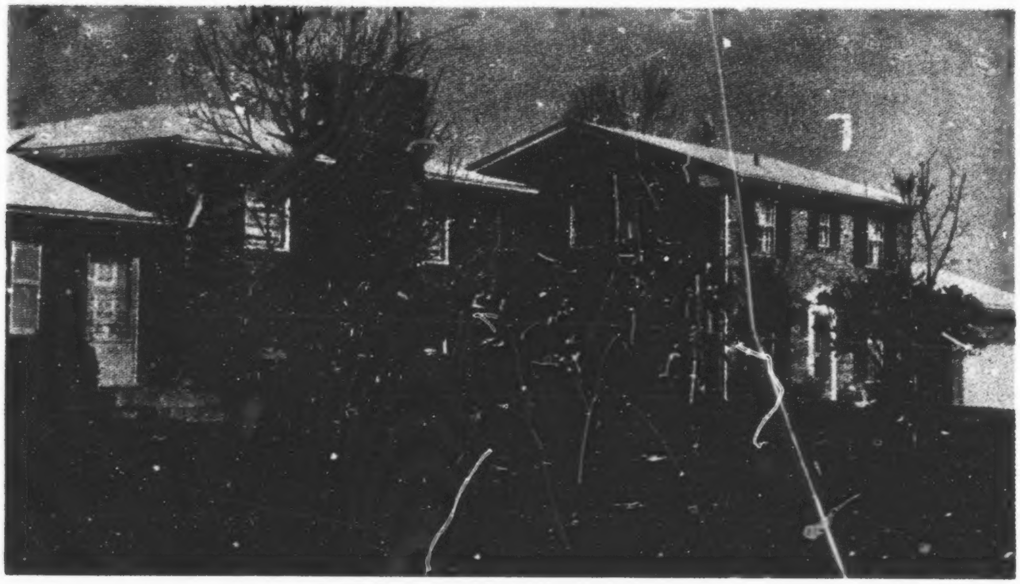


FIG. 22 — TYPICAL HOUSES IN SAMPLE AREA H-2

The results of the door to door census together with the locations of each sample area are presented in Table 10 .

3. Collection and Sorting

Sampling was conducted regularly over a period of one complete year. Collection and sorting was done by private contract with a small local hauler. It was necessary to change contract haulers after nine months and subsequent analysis of the last three months data indicates that the quantity figures may not be reliable. Accordingly, only the first nine months data is reported herein. One sample per month was collected from each house in the sample population. To avoid confusion, arrangements were made with appropriate private and municipal haulers to collect refuse on the normal collection day for the homes involved, but the individual homeowners were not notified of the exact collection day. The collected refuse was taken to the Louisville city incinerator where indoor facilities were available for sorting. The refuse was mixed thoroughly, quartered, and a random quarter selected for hand sorting into five categories; paper and other combustibles, garbage, metal, minerals, glass. A total of thirteen collection cycles were conducted during a twelve month period and approximately 14,000 pounds (1600 cubic feet) of refuse hand sorted.

TABLE 10

Jefferson County Domestic Refuse Sample Areas

Area	Location	Number of People	Number of Households	Persons per Household
L-1	North side of 2000 Block of Garland: 2001-2031	51	16	3.19
L-2	East side of 1300 Block of Floyd: 1319-1351	126	29	4.34
M-1	Both sides of 2300 Block of Dixdale: 2300-2325	78	26	3.04
M-2	Both sides of 1000 Block of Rose Drive: 1033-1062	90	22	4.09
M-3	Both sides of 8200 Block of Joyce Drive: 8200-8217	67	15	4.47
M-4	Both sides of 4700 Block of Libby: 4805-4719	71	16	4.44
H-1	Both sides of 2200 Block of Saratoga: 2211-2257	68	20	3.40
H-2	Both sides of 6400 Block of Regency: 6400-6430	91	26	3.50

4. Domestic Refuse Quantities

The results of the domestic sampling program described in Part III-B-2, as they pertain to domestic refuse quantities, are reported in this section.

a. Average Per Capita Values

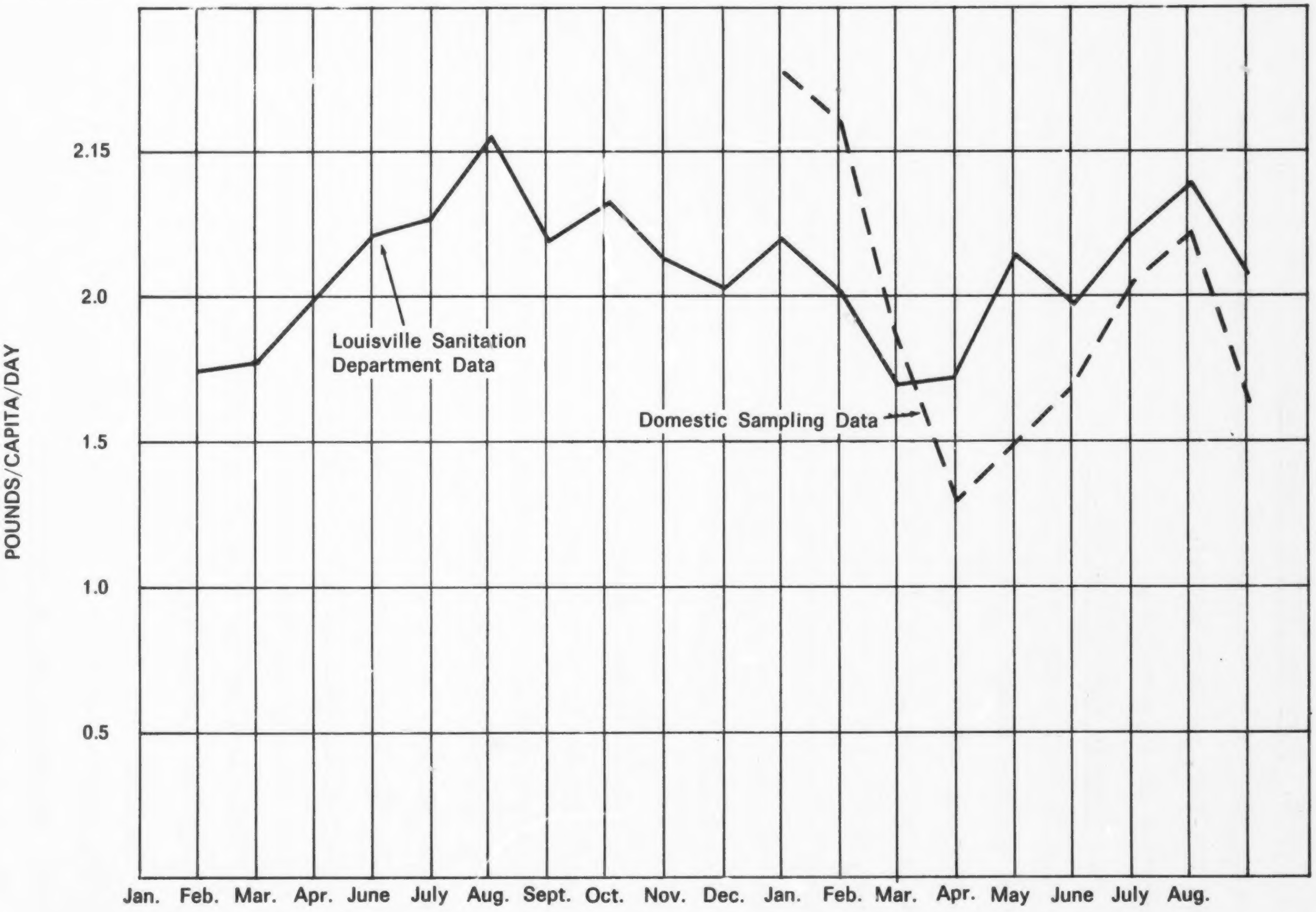
Statistical analysis of domestic refuse data indicated that the average domestic refuse output is 1.97 pounds per capita per day and 0.228 cubic feet per capita per day. Data available from the Louisville Sanitation Department was also analyzed, and resulted in a daily per capita domestic refuse output of 1.99 pounds. A comparison of trends obtained from both sources, as shown in Figure 23 , indicates close agreement.

b. Seasonal Variation

The domestic refuse sampling program covered only one full year, and there was insufficient data available from this information source to permit definite conclusions regarding seasonal variations of refuse quantities. Examination of Louisville Sanitation Department collection data for a period of nineteen months, from January, 1966 through August, 1967 (see Figure 23) however, seems to indicate a recurring cycle. For the period covered the smallest refuse quantities were collected in January and February and the greatest quantities in June. This late spring peak is possibly because of increased outdoor activity and particularly the heavier home and lawn maintenance following winter. Seasonal variation of average per capita values for each income level is shown in Figure 24 .

c. Refuse-Income Relationships

The average refuse composition for each income level is



JANUARY 1966 THROUGH AUGUST 1967

FIG. 23 — SEASONAL VARIATIONS OF DOMESTIC REFUSE

shown in Table 11. These values indicate that lower income families produce less light paper and paper products (including plastic wrappings) than higher income groups but produce more of the heavier garbage, metals and glass. This may account for the relatively minor variations in pounds per capita between low and high income levels as shown in Figure 25.

5. Domestic Refuse Composition

The results of sorting and chemical analysis data is shown in Tables 11 and 12 and Figures 26 and 27 .

TABLE 11

Average Refuse Composition

Jefferson County, Kentucky

November, 1966 - July, 1967

Component		Income Level Low	Medium	High
Paper	% by weight	56.4	62.0	60.6
	% by volume	68.2	75.5	73.3
Garbage	% by weight	20.5	18.7	17.2
	% by volume	9.3	6.8	8.0
Metals	% by weight	10.6	9.1	10.7
	% by volume	16.6	12.9	13.6
Minerals	% by weight	1.3	1.7	0.7
	% by volume	0.7	0.5	0.2
Glass	% by weight	11.2	8.5	10.8
	% by volume	5.2	4.3	4.9

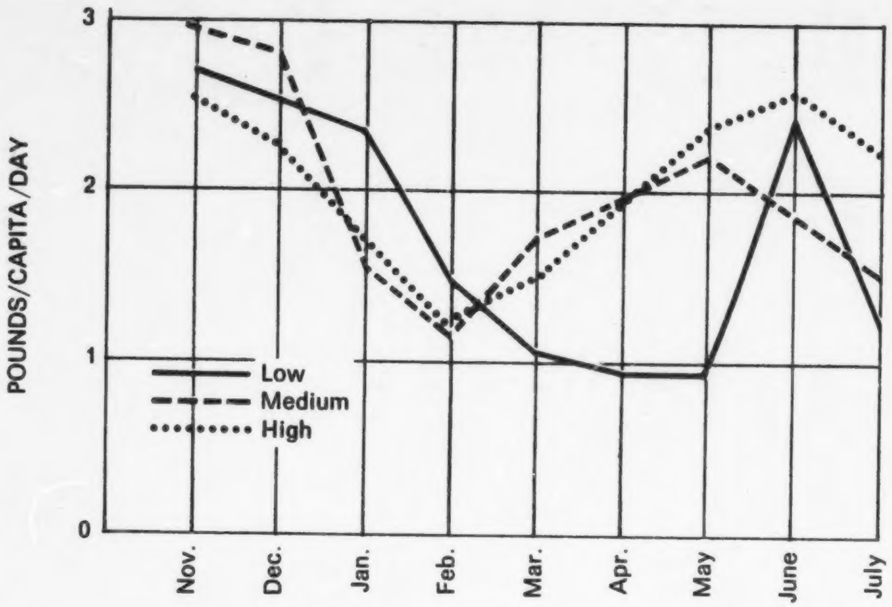


FIG. 24 - 1966-67 SEASONAL VARIATION OF DOMESTIC REFUSE QUANTITIES BY INCOME LEVEL

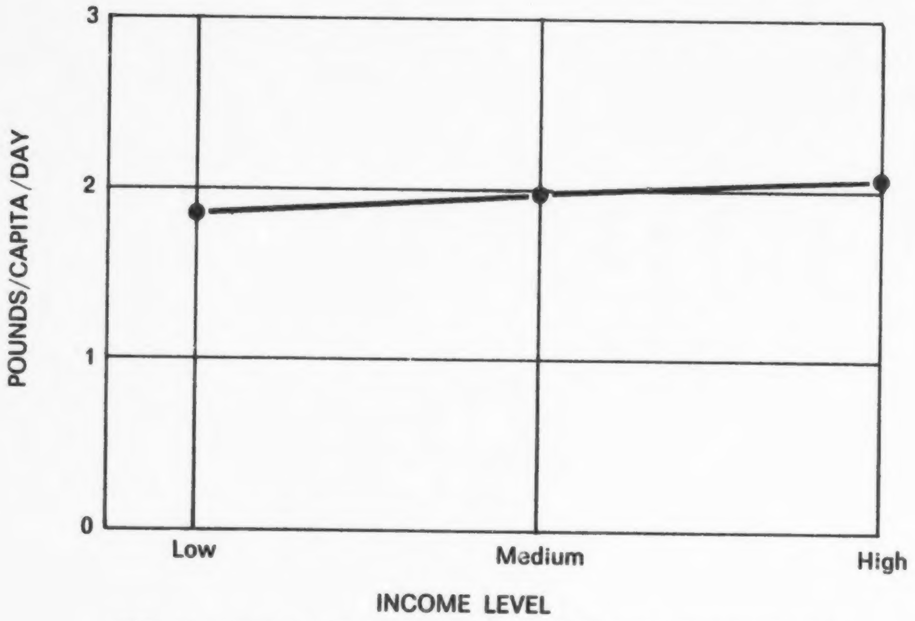


FIG. 25 — PER CAPITA REFUSE QUANTITIES VS. INCOME LEVEL

TABLE 12

CHEMICAL COMPOSITION OF PAPER AND GARBAGE CONTENT OF DOMESTIC WASTE

CHEMICAL COMPONENT	PAPER PERCENT BY DRY WEIGHT			GARBAGE PERCENT BY DRY WEIGHT		
	MEAN	LOWER LIMIT	UPPER LIMIT	MEAN	LOWER LIMIT	UPPER LIMIT
Carbon	44.71	43.98	45.20	43.19	41.38	44.80
Hydrogen	7.44	6.65	8.26	9.40	6.24	13.13
Oxygen	40.66	40.09	41.09	26.64	23.36	30.03
Nitrogen	0.41	0.35	0.47	2.90	2.71	3.10
Sulfur	1.28	0.95	1.66	1.14	0.54	1.95
Phosphorus	0.22	0.07	0.44	1.05	0.79	1.36
Lipids	7.48	5.99	9.11	28.84	26.32	31.41
Ash	4.99	4.30	5.73	15.23	13.74	16.70
Calorific Value (BTU/lb. dry material)	8486	8211	8761	9498	8819	10177

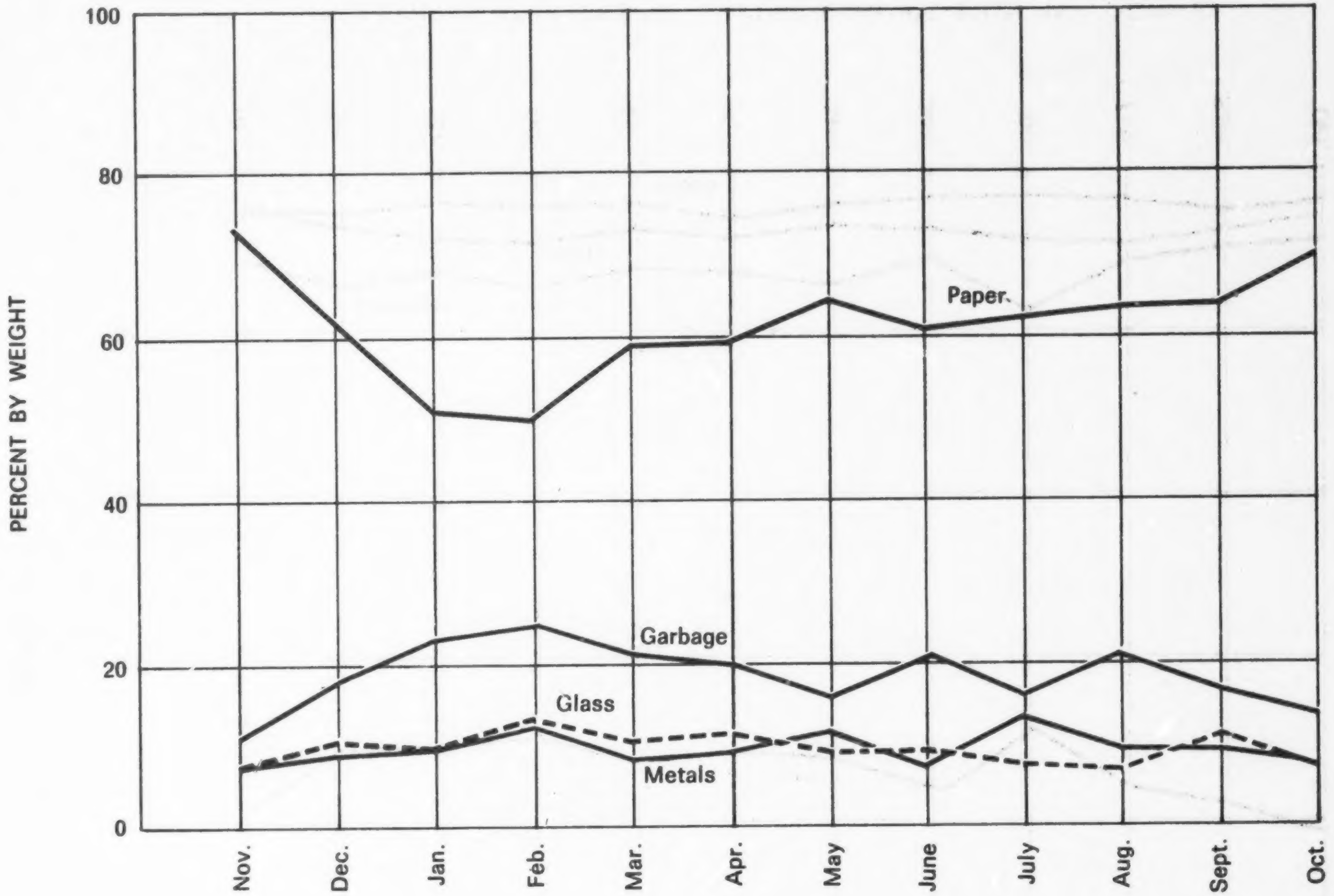


FIG. 26 - 1966-67 DOMESTIC REFUSE COMPOSITION BY WEIGHT

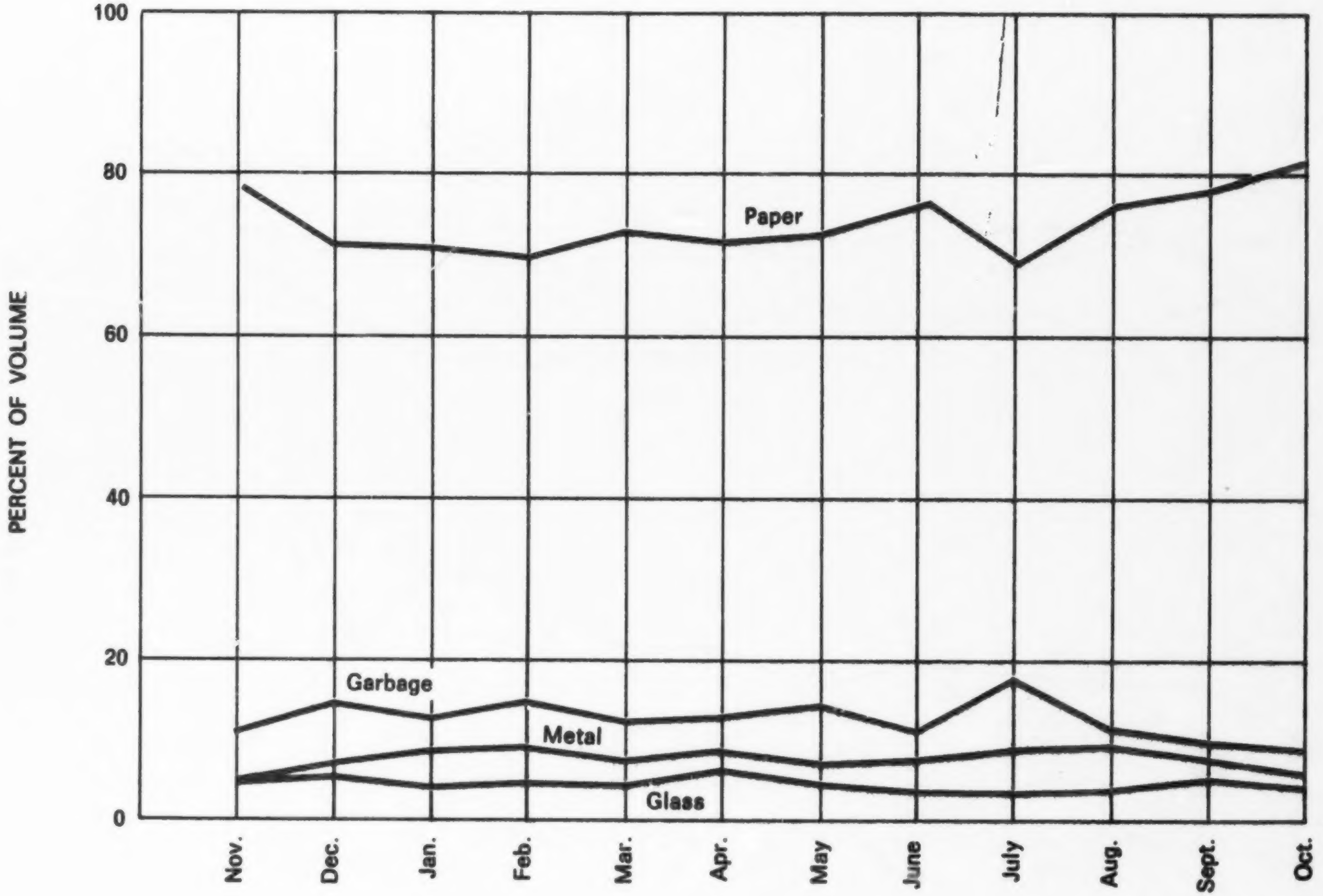


FIG. 27 - 1966-67 DOMESTIC REFUSE COMPOSITION BY VOLUME

III-C. Commercial Refuse

1. General

The quantity of commercial refuse generated over any time period is expected to experience fluctuations. Commercial refuse quantities vary with the general level of business and are not subject to the same calendar variations found in studies of domestic refuse quantities. In the present study it was assumed that the daily fluctuations of refuse were chance variations and that data gathered when averaged represented the mean for the entire year.

2. Data Collection

The procedures followed in collecting data pertaining to commercial refuse are described in this section.

a. Sources of Information

The following sources were used in assembling commercial refuse data:

(1) City of Louisville Sanitation Department - Records from the Louisville Sanitation Department supplied refuse weights for those establishments that haul their own solid wastes to the city incinerator. An "Industrial-Commercial Ticket" is produced for each load of refuse entering the incinerator. On this ticket is marked the date, person or firm to be billed, and weight of load. Over ten thousand of these incinerator weight tickets were sorted and analyzed to determine the quantities of waste hauled to the incinerator by a number of local firms.

(2) Private Haulers - Two of the major commercial-industrial refuse haulers released their records for project

use. Information available included the names of the firms serviced by each collection vehicle, the size of the containers handled, frequency of collection, and, if the refuse had been disposed of at the city incinerator, the total weight. Since the private refuse collection business is highly competitive the records contained no costs or collection fee information.

(3) Small Container Sampling - Information concerning the quantities of refuse produced by commercial establishments using small containers was obtained through a sampling of refuse from such firms. The refuse from 70 commercial establishments was collected, sorted, and weighed. The firms sampled from each business category were in the same proportion as that of the business category throughout the county, both with respect to numbers of firms and to size of establishment within a particular category.

(4) Telephone Survey - Employment data was gathered by a telephone survey of all firms sampled. This survey included firms using large, intermediate, and small containers. A second, and more extensive phone survey was conducted to determine the distribution of three container sizes throughout the county. Using a table of random numbers, a telephone index, and a code designed to translate random numbers into telephone numbers, six groups of twenty-five commercial establishments were contacted. These firms were asked the manner of disposal, collection agency, and volume of refuse containers used.

(5) Questionnaires - Questionnaires were mailed to

approximately 40 per cent of the groceries and restaurants and 100 per cent of the hotels, and hospitals in Jefferson County. Less than 30 percent of those contacted replied, and less than 20 per cent of those replying could supply useful information. Because of the poor response to the questionnaires and the unreliability of those few replies received, questionnaire data were not used.

3. Commercial Refuse Quantities

The results of analysis of commercial refuse quantity data are reported in this section.

a. Refuse Quantities by Size of Firm

Statistical analysis of all commercial refuse data indicated that there are four distinct categories of commercial firms with respect to quantity of commercial refuse generated by a firm, and that the categories are related to firms who use small, intermediate, or large refuse containers as their mode of refuse disposal, or firms who are located in office buildings. Firms located in office buildings generally produce less refuse per employee than other firms. Firms not located in office buildings usually have refuse quantities related to size of container used for disposal. Detailed information and sample computations pertaining to commercial refuse sampling are given in the Separate Appendix.

Table 13 presents the mean of each refuse producing category and the corresponding percentage of total commercial refuse population that each category represents. A weighted average, based on the percentage of commercial refuse collected by each size container system, was used to estimate the geographic distribution of commercial refuse in Jefferson County.

TABLE 13

Categories of Commercial Refuse Production in Jefferson County

Refuse Production Level	Mean Quantity Pounds per Commercial Employee per Calendar Day.	% Category Represents of Total Commercial Population.
Office Building Tenants	1.10	10.6
Small Container Users (Less than 2 yd.)	2.12	67.4
Intermediate Container Users (2-10 yd.)	7.28	10.6
Large Container Users and Self Disposers (More than 10 yd.)	18.69	11.3
Weighted Average	4.57	

Using employment and quantity data obtained as described in Part III-C-2 the relationship between refuse production and employment was determined for each of the three categories of commercial waste production except for office building tenants.

Figures 28, 29, and 30 present the relationship between pounds of commercial refuse per calendar day for users of small, intermediate, and large containers. Because of the variation in the data and because of the large number of data available, the quantities of refuse from commercial establishments having similar employment levels were averaged and then plotted against the median employment of those firms. Median employment was used to minimize the effect of the extremely wide range present in the employees per firm parameters.

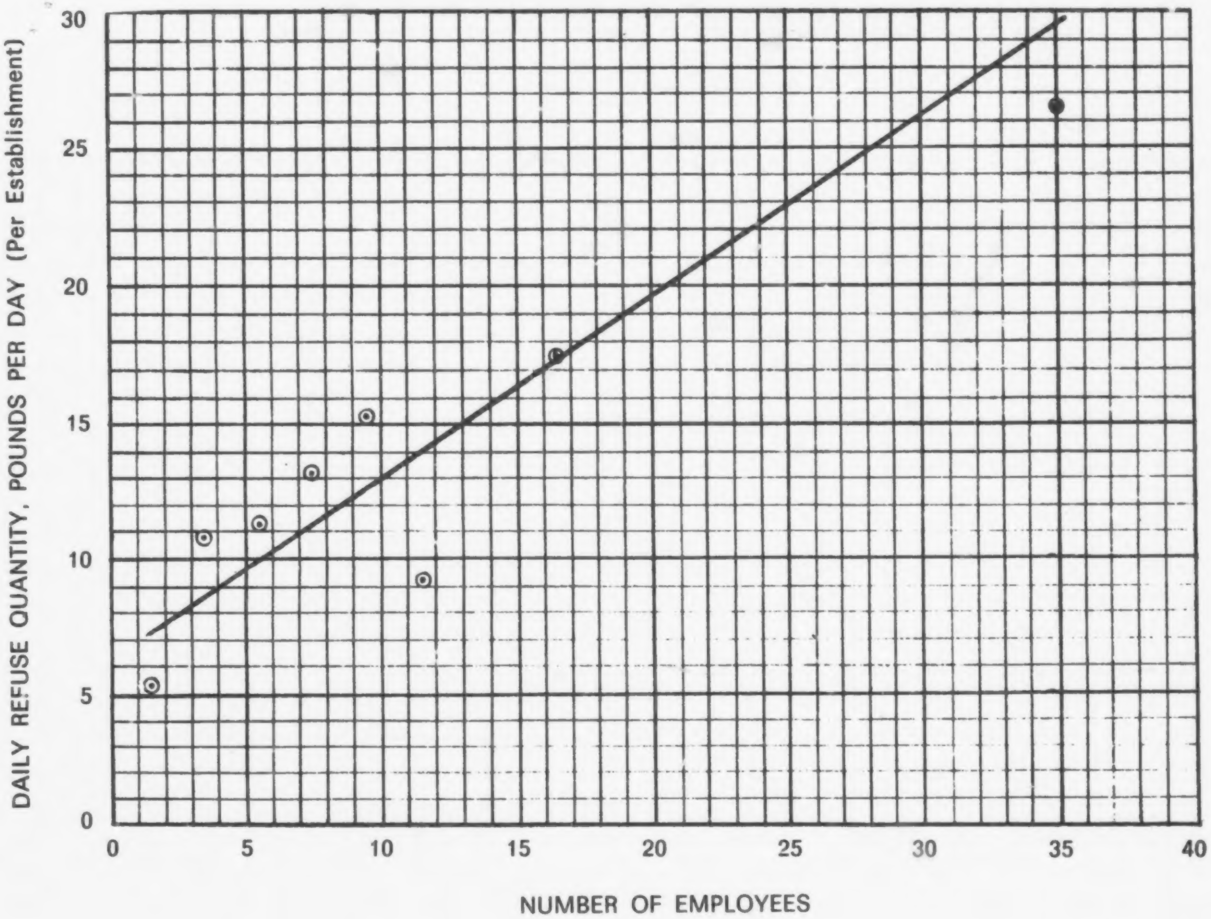


FIG. 28 — VARIATION OF QUANTITY OF COMMERCIAL REFUSE WITH EMPLOYMENT FOR USERS OF SMALL CONTAINERS

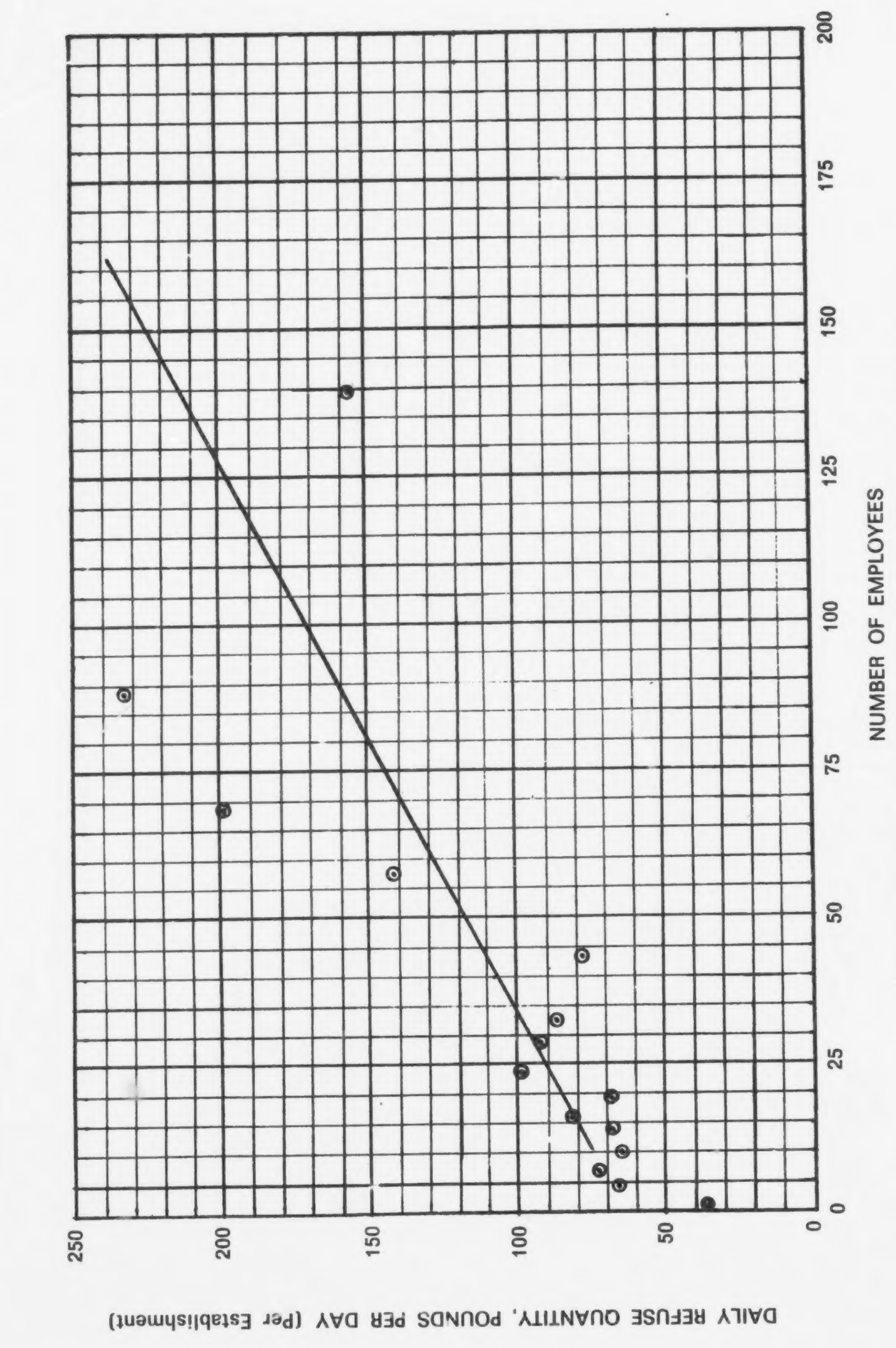


FIG. 29 — VARIATION OF QUANTITY OF COMMERCIAL REFUSE WITH EMPLOYMENT FOR USERS OF INTERMEDIATE CONTAINERS

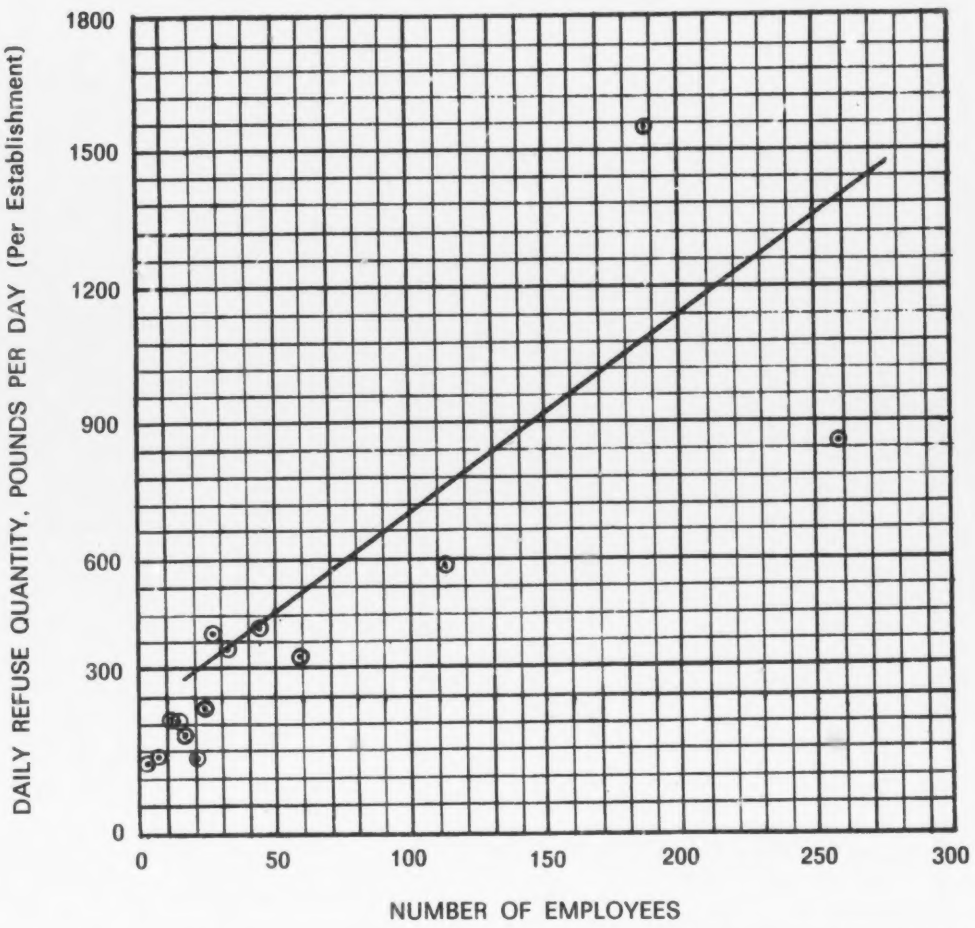


FIG. 30 — VARIATION OF QUANTITY OF COMMERCIAL REFUSE WITH EMPLOYMENT FOR USERS OF LARGE CONTAINERS

These figures clearly show that, on the average, large companies produce more refuse than do small companies.

The solid curves shown on each figure were determined by the method of least squares. In the Special Appendix, data for the above figures are presented in tabular form together with the number of points in each grouping.

Although the total quantity of refuse produced by commercial firms increases with increasing employment, the quantity of refuse per employee decreases with increasing employment, for the three categories related to container size. The relations between daily pounds per employee and commercial employees are presented in Figures 31, 32, and 33.

b. Quantity of Commercial Refuse by Type of Firm

The characteristics and quantity of refuse produced by commercial enterprises vary between firms of different types. For the purpose of this report, commercial establishments have been categorized as shown in Table 14. The classification is a modification given by the Louisville Employment Security Office in labor statistics publications.

In order to determine the quantity of refuse produced per employee per day for firms of different types, the data were divided according to firm type for the three levels of container size used. These data were then averaged to obtain mean lbs. per employee per day values for individual firms on each level.

Table 15 presents the refuse production rates per employee for firms of different types for the three categories

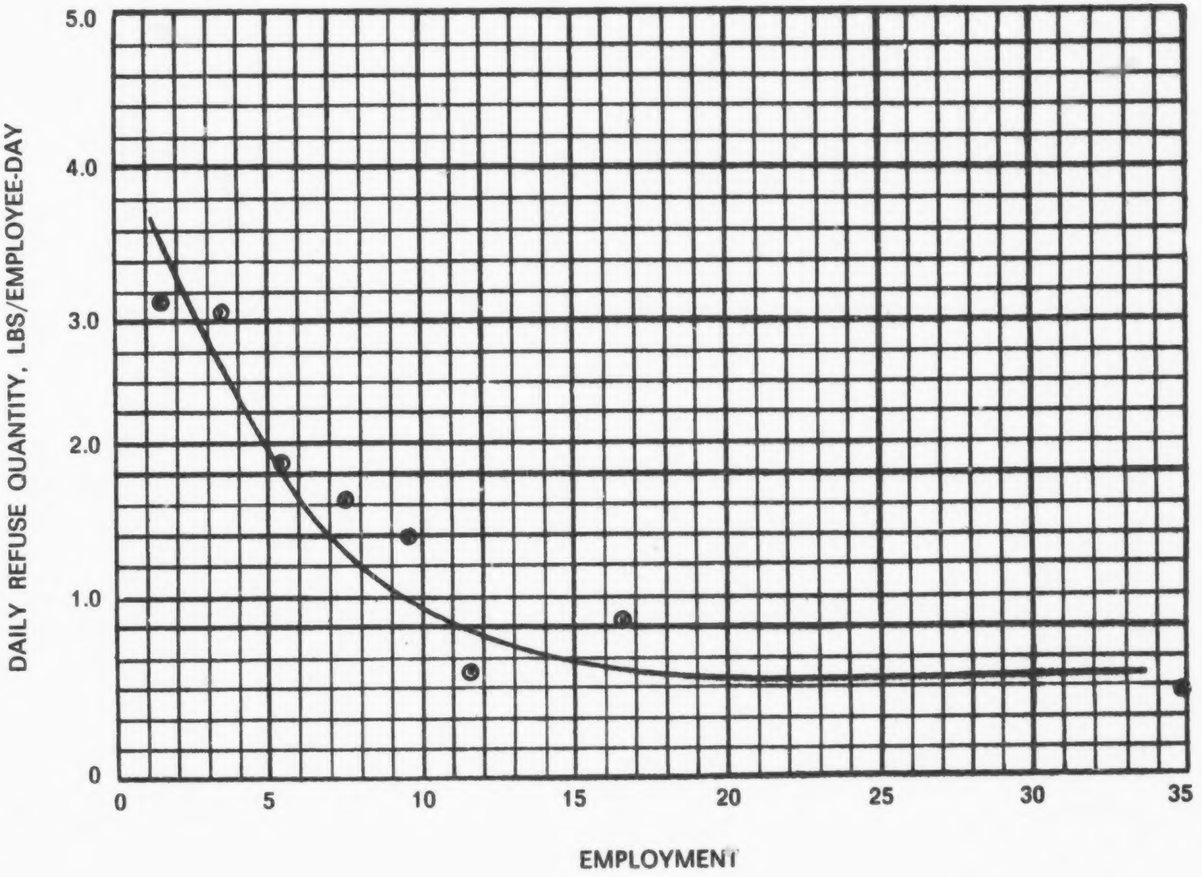


FIG. 31 — VARIATION OF REFUSE QUANTITY PER EMPLOYEE WITH EMPLOYMENT FOR USERS OF SMALL CONTAINERS

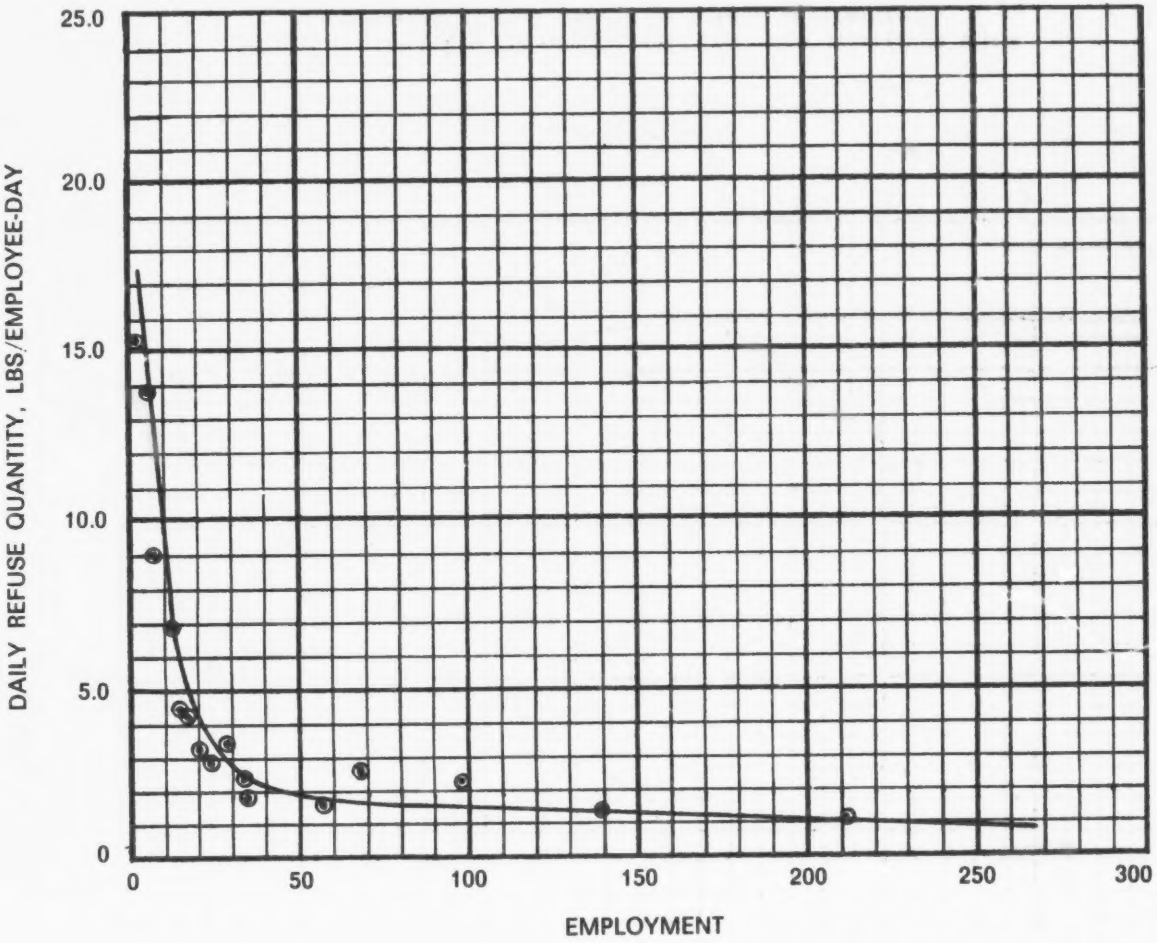


FIG. 32 — VARIATION OF REFUSE QUANTITY PER EMPLOYEE WITH EMPLOYMENT FOR USERS OF INTERMEDIATE CONTAINERS

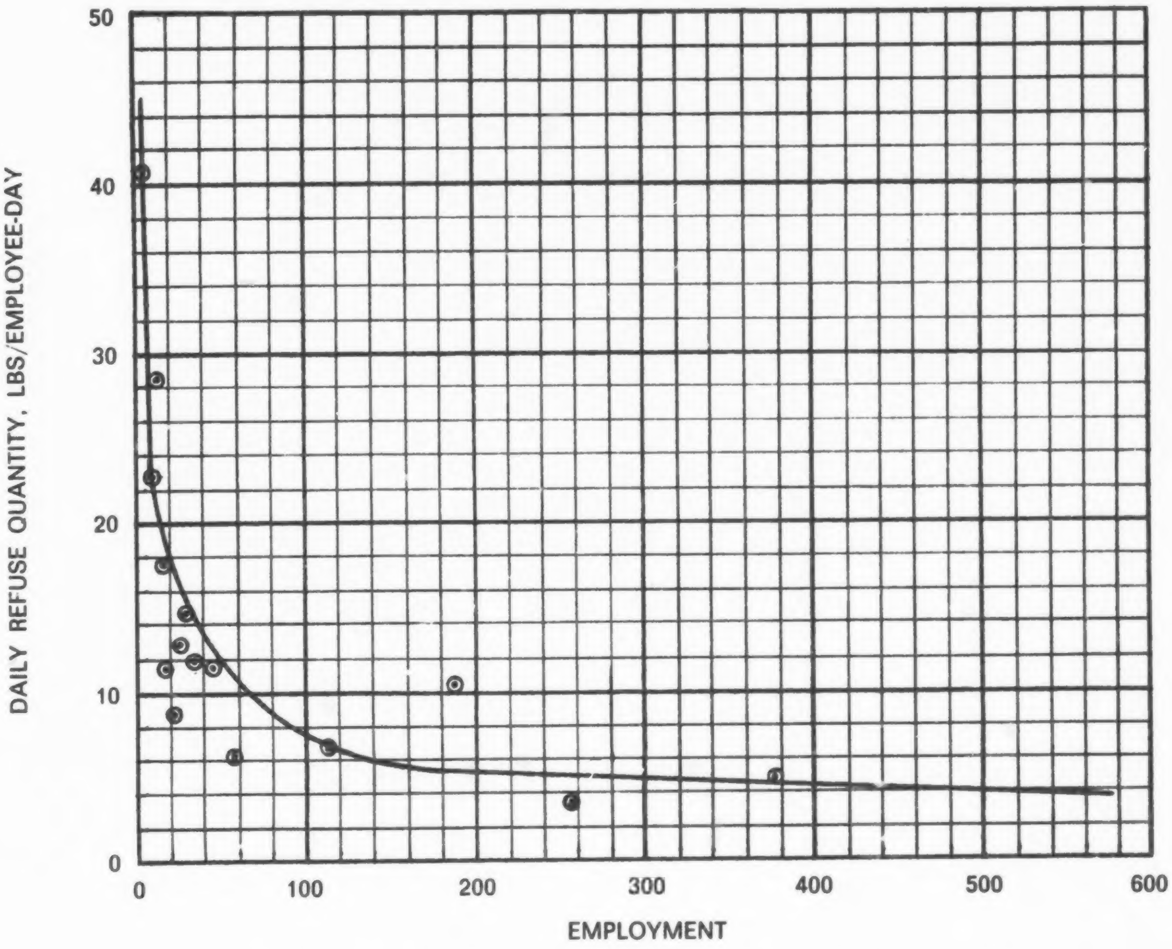


FIG. 33 — VARIATION OF REFUSE QUANTITY PER EMPLOYEE WITH EMPLOYMENT FOR USERS OF LARGE CONTAINERS

TABLE 14

Classification of Commercial Establishments

1. Wholesale Trade
2. Retail Building Materials
3. Retail General Merchandise
4. Retail Food
5. Auto (Sales, Service Station, Garages, Repair, etc.)
6. Retail Apparel
7. Furniture
8. Eating and Drinking Establishments
9. Miscellaneous Retail Trade
10. Finance (Banking, Insurance, Real Estate, etc.)
11. Hotel
12. Personal Service
13. Business Services
14. Miscellaneous Repair
15. Amusements and Recreation
16. Medical and Health
17. Non Profit
18. Miscellaneous Services

TABLE 15

Variation of Quantity of Commercial Refuse Within Commercial Categories

	Category	Average Lbs. per Employee per Calendar Day			
		Small Containers	Intermediate Containers	Large Containers	1967 Employment
1.	Wholesale	--	3.18	23.96	16,600
2.	Retail Building Materials	--	2.25	35.72	1,790
3.	Retail General Merchandise	0.85	1.42	3.05	9,100
4.	Retail Food	2.29	18.73	17.03	7,600
5.	Auto	2.40	13.17	14.49	8,300
6.	Retail Apparel	2.17	4.12	---	3,000
7.	Furniture	0.88	3.36	9.43	2,100
8.	Eating and Drinking	1.47	7.30	9.37	9,900
9.	Miscellaneous Retail Trade	1.74	7.89	9.44	6,600
10.	Finance	1.07	9.86	23.12	15,700
11.	Hotel	1.83	6.22	---	2,500
12.	Personal Services	0.75	2.73	16.43	5,400
13.	Business Services	3.81	5.07	8.95	4,900
14.	Miscellaneous Repair	2.50	20.90	7.19	590
15.	Amusements and Recreation	0.99	2.65	---	2,650
16.	Medical and Health	1.95	2.91	5.24	10,600
17.	Non Profit	1.08	2.08	16.21	5,500
18.	Miscellaneous Services	3.84	5.09	13.84	1,350

of container size. The employment of each category is also presented, to show the relative size of each category.

4. Commercial Refuse Characteristics

a. Physical Composition - All wastes produced by fifty-three commercial enterprises were collected at the firm's usual collection time, and hand sorted into the following components: paper, garbage, metal, plastics, and minerals. Mean values for each component of commercial refuse are presented in Table 16a. A detailed breakdown of composition by type of firm is shown in the Separate Appendix.

b. Density

The refuse was determined to have uncompacted bulk density in the container of 186.8 ± 25.6 pounds per cubic yard at the 90 per cent confidence level. This compared favorably with a value of 172.0 ± 8.7 pounds per cubic yard, obtained by analysis of volumes and weights for intermediate containers supplied by one of the private haulers. This latter figure was computed based on the assumption that all containers were full when collected. The close agreement between the two independently derived densities, together with the results of interviews with refuse vehicle operators and personal observations by the study staff, indicates that this was a valid assumption.

c. Chemical Properties

Eight composite samples, picked randomly from those sorted, were selected for laboratory analysis. Four of the

TABLE 16a

PHYSICAL COMPOSITION OF COMMERCIAL REFUSE
(90 PER CENT CONFIDENCE LEVEL)

COMPONENT	TOTAL COMMERCIAL REFUSE			COMMERCIAL SWILL			COMMERCIAL REFUSE		
	AVERAGE PER CENT	LOWER LIMIT	UPPER LIMIT	AVERAGE PER CENT	LOWER LIMIT	UPPER LIMIT	AVERAGE PER CENT	LOWER LIMIT	UPPER LIMIT
PAPER WGT.	60.36	52.20	66.22	42.11	33.56	50.71	68.99	60.28	74.97
PAPER VOL.	76.39	70.56	78.15	69.21	60.71	74.97	79.77	72.95	81.46
GARBAGE WGT.	7.14	4.89	9.79	14.14	8.16	21.44	3.84	2.29	5.77
GARBAGE VOL.	2.78	1.87	3.86	5.19	2.70	8.42	1.64	0.97	2.48
PLASTIC WGT.	9.35	6.62	12.50	7.99	4.31	12.69	9.99	6.42	14.25
PLASTIC VOL.	11.63	8.83	14.76	10.51	6.92	14.74	12.16	8.42	16.48
METAL WGT.	10.58	7.86	13.64	11.11	7.34	15.54	10.33	6.86	14.41
METAL VOL.	5.99	4.26	7.99	7.48	4.23	11.56	5.28	3.37	7.60
GLASS WGT.	11.32	7.99	15.13	21.31	12.12	32.26	6.60	4.30	9.34
GLASS VOL.	2.59	1.76	3.57	5.78	3.05	9.23	1.08	0.68	1.57
MINERAL WGT.	1.21	0.71	1.84	3.28	1.15	6.45	0.23	0.12	0.37
MINERAL VOL.	0.60	0.36	0.91	1.76	0.64	3.42	0.05	0.03	0.09

samples were of garbage. The remaining four were of combustibles other than foodstuffs, primarily plastics and paper. The results of this laboratory analysis is given in Table 16b .

TABLE 16 b

Laboratory Analysis of Commercial Refuse

Garbage

Sample Number	1	2	3	4
Analysis				
Per Cent Moisture (Wet Basis)	51.2	64.7	73.4	58.4
Per Cent Ash (Dry Basis)	14.8	14.1	12.0	18.4
Per Cent Lipids (Dry Basis)	12.0	21.3	13.9	26.6
Calorific Value (BTU/lb. dry material)	9442	8633	9133	9719

Other Combustibles

Sample Number	1	2	3	4
Analysis				
Per Cent Moisture (Wet Basis)	11.3	22.4	18.8	27.2
Per Cent Ash (Dry Basis)	4.0	3.7	6.4	6.3
Per Cent Lipids (Dry Basis)	1.0	0.3	2.4	4.3
Calorific Value (BTU/lb. dry material)	9250	7937	8038	7582

III-D. Industrial Refuse

1. General

This phase of the study was divided into three categories: composition of waste, method of collection and disposal of waste, and type of industry generating the waste. These three categories and the subdivisions of each are given in Tables 17 and 18 .

TABLE 17

Categories of Industrial Waste Classification

Classification by Composition

1. Chemical
2. Foodstuffs
3. Glass
4. Metal
5. Mineral
6. Paper
7. Plastics and Rubber
8. Textiles
9. Wood
10. Other

Classification by Collection & Disposal Responsibility

1. Collected and disposed of by private or public agencies.
2. Collected and disposed of by company employees.
3. Wastes salvaged or sold.

TABLE 18

Categories of Industrial Waste Classification

Classification by Industry Type

Heavy Industries

1. Beverage Industries
2. Chemical and Allied Products
3. Fabricated Metal Products
4. Lumber and Products, except Furniture
5. Electrical Machinery
6. Machinery, except Electrical
7. Petroleum and Coal Products
8. Primary Metal Industries
9. Stone, Clay and Glass Products

Light Industries

10. Apparel and Related Products
11. Food and Kindred Products
12. Furniture and Fixtures
13. Instruments
14. Leather and Leather Products
15. Machine Shops
16. Ordnance and Accessories
17. Paper and Allied Products
18. Printing and Publishing Industries
19. Rubber and Allied Products
20. Textile Mill Products
21. Tobacco Manufacturers
22. Transportation Equipment
23. Miscellaneous Manufacturers.

2. Data Collection

Because of the extremely wide diversification of type and size of industries in Jefferson County, collection of useful data pertaining to industrial refuse production required methods somewhat different than those employed for the domestic and commercial refuse components. These methods were :

a. Questionnaires

Questionnaires were the primary source of information on industrial refuse. Three separate questionnaire mailings were conducted during the study period.

(1) Questionnaire No. 1 - This questionnaire was sent to all 306 industrial firms in Jefferson County having more than 25 employees. The questionnaire requested data on quantities of each type of waste generated, e.g. chemical, paper, wood, etc., and also asked for the name of a company employee who could be contacted for additional information. Replies were received from 65 per cent of those contacted. There was no analysis of non response error.

(2) Questionnaire No. 2 - This questionnaire was sent to the 551 industrial firms having fewer than 25 employees plus those large companies that did not reply to the initial mailing. In addition to requesting the quantities of each refuse type, this questionnaire also asked for a break down by disposal method, i.e. salvage, private hauler, self disposal. Thirty-seven per cent of these questionnaires were returned.

(3) Questionnaire No. 3 - This questionnaire was sent to all larger firms which had responded to the first questionnaire, and requested employment data and disposal methods.

(4) Use of Questionnaires - Not all questionnaire replies contained accurate and useable information. Cross checks with private and municipal refuse collection and disposal sources indicated that a sizeable number of industries were not aware of the quantities of refuse they produced. Table 19 summarizes the results of the questionnaire phase of industrial refuse data collection.

b. Personal Contact

To increase the percentage of questionnaires returned, and to improve the accuracy of the data supplied, personal contact was made with many of the firms; first, to encourage return of the questionnaire, and second, to check on possible inaccuracies in questionnaire replies.

(1) Telephone Contacts - Those firms having more than 500 employees were contacted by telephone, concurrent with mailing of Questionnaire No. 1, to insure that the questionnaires were not lost in intracompany mail. Prior to mailing Questionnaire No. 2, a sample group of companies was contacted by telephone, and the objectives of the questionnaire explained to the person who was to complete it. Of the group contacted by telephone, 46 per cent completed and returned questionnaire No. 2, while replies were received from only 33 per cent of the firms not contacted.

TABLE 19

Results From Questionnaires

Type of Industry	Questionnaire No. 1 Results		Questionnaire No. 2 Results		Questionnaire No. 3 Results		Questionnaires Personally Delivered		Questionnaire Used	
	Sent	Returned	Sent	Returned	Sent	Returned	Sent	Returned	No.1	No.2 & 3
Apparel & Related Products	5	4	23	10	8	6	1	0	0	8
Beverage Industries	17	13	5	4	13	5	2	2	6	9
Chemical and Allied Products	28	16	38	20	22	11	5	3	2	19
Fabricated Metal Products	37	22	64	28	34	10	4	2	11	29
Food and Kindred Products	45	30	57	20	42	3	0	0	14	24
Furniture Fixtures	12	7	34	19	10	3	0	0	2	17
Instruments	4	2	11	4	3	0	0	0	1	3
Leather and Leather Products	0	0	4	2	0	0	0	0	0	0
Lumber and Lumber Products	18	10	30	9	16	8	1	1	5	10
Electrical Machinery	9	4	14	5	3	1	0	0	1	7
Machinery, except Electrical	19	14	52	18	17	8	1	1	5	10
Machine Shops	7	3	24	6	3	1	0	0	1	3

TABLE 19 (Continued)

Type of Industry	Questionnaire No. 1 Results Sent	Questionnaire No. 1 Results Returned	Questionnaire No. 2 Results Sent	Questionnaire No. 2 Results Returned	Questionnaire No. 3 Results Sent	Questionnaire No. 3 Results Returned	Questionnaires Personally Delivered Sent	Questionnaires Personally Delivered Returned	Questionnaire Used No. 1	Questionnaire Used No.2 & 3
Ordnance and Accessories										
Paper and Allied Products	12	9	18	8	10	4	0	0	6	10
Petroleum and Coal Products	3	3	8	4	3	0	0	0	2	2
Primary Metal Industries	9	5	7	0	4	0	0	0	5	0
Printing and Publishing Industries	30	20	95	26	29	14	2	0	8	28
Rubber and Plastic Products	0	0	9	4	0	0	0	0	0	3
Stone, Clay and Glass Products	24	10	21	10	17	4	0	0	8	10
Textile Mill Products	2	2	2	0	2	2	0	0	1	1
Tobacco Manufacturers	9	6	1	0	7	1	0	0	5	1
Transportation Equipment	5	2	4	1	4	1	0	0	2	1
Miscellaneous Manufacturers	11	7	30	5	8	2	0	0	1	0
Total	306	189	551	203	255	99	17	9	84	202

(2) On Site Interviews - Following each questionnaire mailing a selected sample of companies receiving questionnaires were visited and interviews held with those employees responsible for refuse disposal. Over forty interviews were conducted during the course of the study.

c. Private Haulers

The private refuse haulers were contacted early in the project. Their cooperation was considered essential since they account for over half of the industrial refuse collected in Jefferson County. Most of the private haulers were very cooperative, and two major industrial refuse haulers provided volume and weight data, from their records, for 52 companies and volume data for 79 others.

Invoices and billing records obtained from the haulers, were the prime source of data, and were used without modification. These data represented periods of as much as six months. The data for each company was averaged and the mean value was used as typical of the refuse output for that company.

d. City of Louisville Sanitation Department

Louisville offers a limited refuse disposal service to industrial companies. The Louisville Sanitation Department provided information on the volumes of industrial wastes collected from 23 small industrial firms. These firms are serviced by the municipal collection system and pay fees for the collection of more than two garbage cans.

The Louisville Sanitation Department also provides dumpster service on a fee basis. Using this source of information, both volume and weight data for a twelve-month period were collected for thirteen companies.

Information was also obtained on the number of private firms using city disposal facilities for refuse hauled by company employees.

e. Refuse Sampling

Since much of the data obtained from the sources listed in section D-2 were refuse volumes, or weights, but not both, it was necessary to determine the bulk density of typical components of industrial refuse. The refuse of thirteen industrial firms in Jefferson County was sampled just before a normal refuse collection; six of the companies separated the wastes for different methods of disposal. Thirty different bulk dinsities were determined on location for different types of homogeneous industrial waste.

3. Industrial Refuse Quantities

The results of analysis of refuse quantity data are reported in this section.

a. Refuse Quantities - Per Employee

Industrial refuse quantities were analyzed on the basis of pounds per production employee per day. The ratio of industrial production employees to total employees is approximately 0.77 and is applicable throughout Jefferson County as shown in Table 20. The per employee refuse generation values for different types of industries varied widely as shown in Table 21 .

The quantity of refuse produced per employee was observed to vary with industry size as well as type of industry.

TABLE 20

Employment Characteristics of Different Industry Types

Type of Industry	Number in Jefferson County	Number of Full Time Employees	Number of Production Employees	Ratio Number of Production Employees / Number of Full Time Employees
Apparel and Related Products	31	1,638	1,421	.783
Beverage Industries	22	6,314	4,641	.780
Chemical and Allied Products	67	8,300	6,149	.757
Fabricated Metal Products	97	9,492	7,345	.749
Food and Kindred Products	100	6,830	5,341	.794
Furniture and Fixtures	45	2,299	1,807	.836
Instruments	14	259	155	.783
Leather and Leather Products	4	31	24	.783
Lumber and Products, except Furniture	48	2,708	2,213	.836
Electrical Machinery	19	14,831	10,428	.704
Machinery, except Electrical	73	10,981	8,234	.704
Machine Shops	28	399	322	.783
Ordnance and Accessories	1	2,700	2,114	.783
Paper and Allied Products	28	1,622	1,427	.799
Petroleum and Coal Products	11	390	1,421	.783
Primary Metal Industries	12	1.724	4.641	.783

TABLE 20 (Continued)

Type of Industry	Number in Jefferson County	Number of Full Time Employees	Number of Production Employees	Ratio Number of Production Employees / Number of Full Time Employees
Printing and Publishing Industries	126	6,208	5,036	.783
Rubber and Plastic Products	9	240	215	.783
Stone, Clay and Glass Products	44	2,589	1,835	.783
Textile Mill Products	4	406	343	.783
Tobacco Manufacturers	9	8,234	7,167	.783
Transportation Equipment	7	4,276	3,725	.783
Miscellaneous Manufacturers	39	985	779	.783
Average	822	93,456	71,897	.77

TABLE 21

Employee Refuse Output by Type of Industry

Type of Industry	Pounds Per Production Employee Per Week
Apparel and Related Products	71.21
Beverage Industries	364.19
Chemical and Allied Products	679.42
Fabricated Metal Products	152.86
Food and Kindred Products	188.32
Furniture and Fixtures	58.85
Instruments	7.36
Leather and Leather Products	167.00
Lumber and Products, except Furniture	725.28
Electrical Machinery	82.62
Machinery, except Electrical	189.15
Machine Shops	25.73
Ordnance and Accessories	107.78
Paper and Allied Products	156.73
Petroleum and Coal Products	2444.54
Primary Metal Industries	230.49
Printing and Publishing Industries	46.76
Rubber and Plastic Products	46.64
Stone, Clay and Glass Products	1196.52
Textile Mill Products	5.68
Tobacco Manufacturers	54.93
Transportation Equipment	44.97
Miscellaneous Manufacturers	774.29
Average	238.00

Industry types were grouped into the broad categories of heavy and light industries as shown in Table 18.

Figures 33 and 34 indicate lower refuse quantities per employee with increasing industry size. This is attributable largely to the improved production efficiencies and increased salvage volumes made possible through mass production.

The existence of two distinct curves shifting sharply at a point where the plant size is approximately 100 production employees apparently is caused by the fact that automation becomes a significant factor at this point in the size of most industries. A contributing factor could be that many large firms operate their own coal fueled steam plants with ash disposal needs, whereas the smaller firms use natural gas and power purchased from the utility company. The operation of coal fired boilers, with the attendant ash or clinker, greatly increases a plant's volume of solid wastes.

b. Refuse Quantities - By Industry Type

The total quantities of industrial wastes generated in Jefferson County, by industry type and method of disposal is given in Table 22 and Figures 35 , 36 , and 37 . Of the approximately 17 million pounds of industrial solid wastes presently being generated weekly in Jefferson County, 21 per cent is salvaged, 52 per cent is collected by private or municipal haulers, and 27 per cent is disposed of by the industries using their own manpower and equipment.

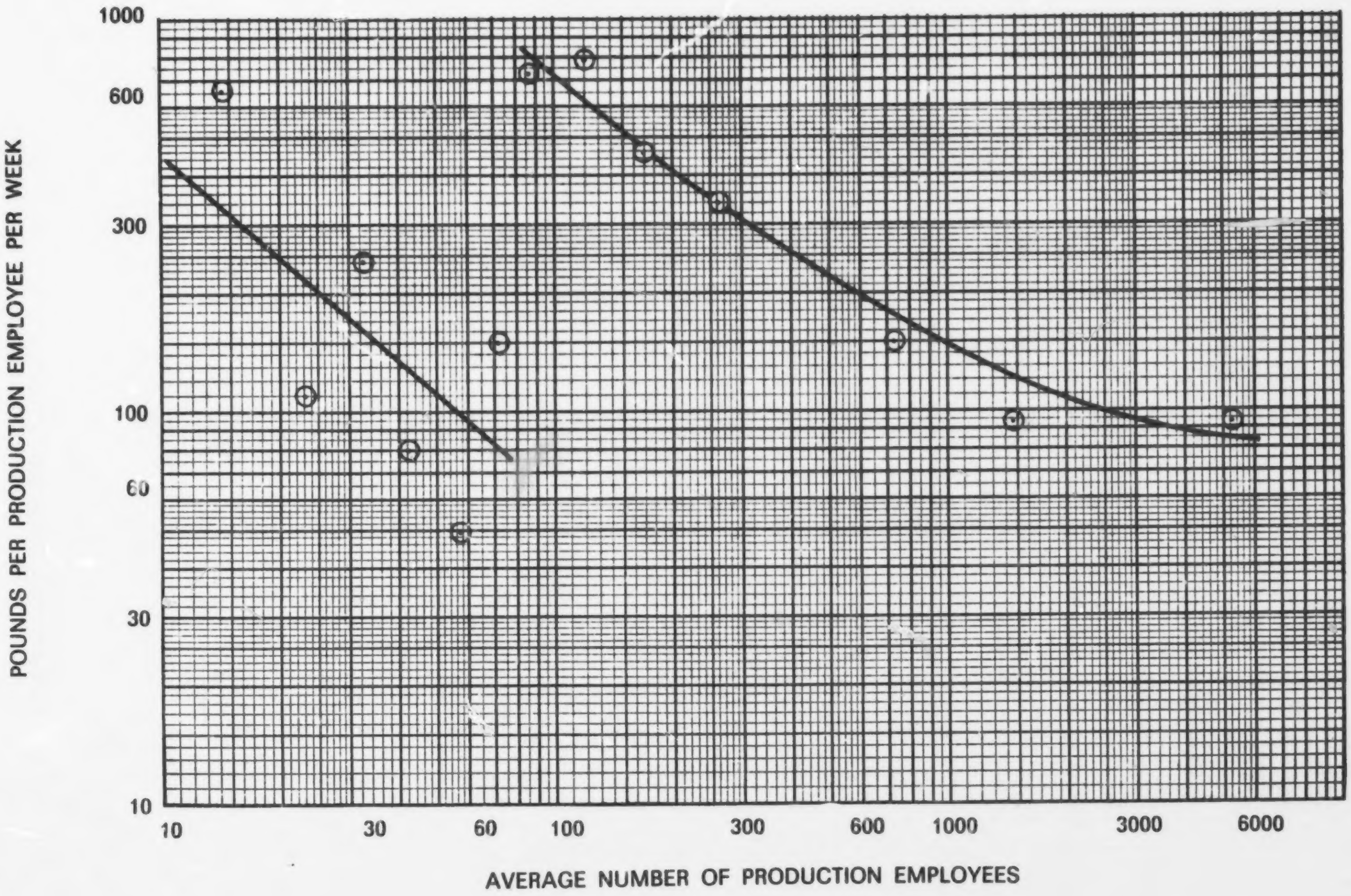


FIG. 33 — GROUPED DATA FOR THE HEAVY PRODUCTION INDUSTRIES

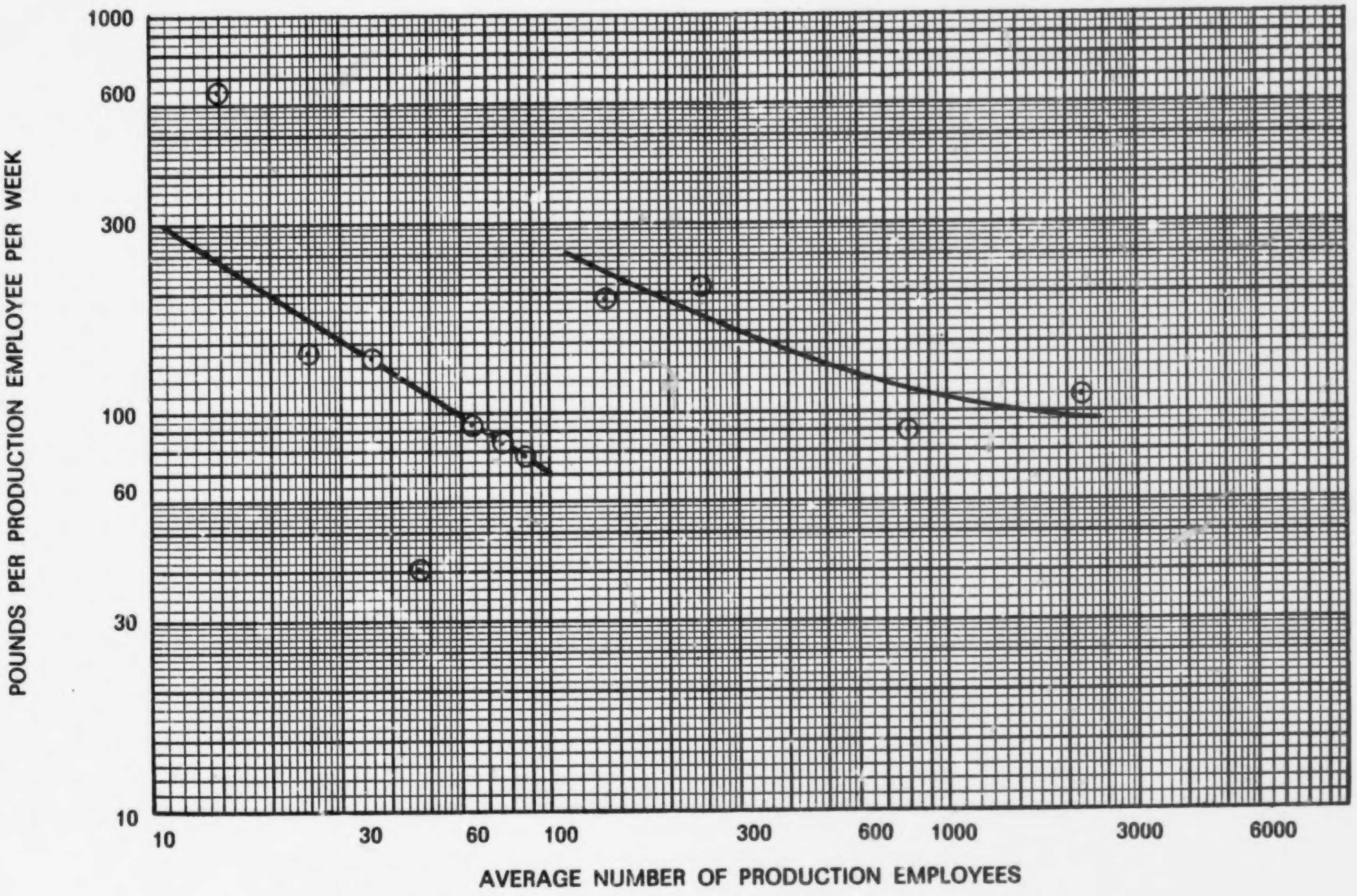


FIG. 34 — GROUPED DATA FOR THE LIGHT PRODUCTION INDUSTRIES

TABLE 22

Industrial Wastes Generated in Jefferson County

Type of Industry	Method of Disposal Pounds per Week Salvaged	Private Hauler	Disposed of by Company	Total
Apparel and Related Products	57,980	37,340	340	95,660
Beverage Industries	803,940	493,690	372,730	1,670,360
Chemical and Allied Products	452,150	2,669,450	758,390	3,874,990
Fabricated Metal Products	700,260	256,440	32,310	989,010
Food and Kindred Products	97,500	655,700	46,230	799,430
Furniture and Fixtures	10,420	63,640	34,810	108,870
Instruments	20	5,440	40	5,500
Leather and Leather Products		5,320		5,320
Lumber and Products, except Furniture	208,670	242,170	1,101,880	1,552,720
Electrical Machinery	54,800	27,010	799,000	875,810
Machinery, except Electrical	278,730	708,400	43,720	1,030,850
Machine Shops	910	7,650	480	9,040
Ordnance and Accessories	66,720	133,360	29,800	229,880
Paper and Allied Products	663,300	96,490	17,330	777,120
Petroleum and Coal Products		152,550	385,000	537,550

TABLE 22 (Continued)

Type of Industry	Salvaged	Method of Disposal Pounds per Week Private Hauler	Disposed of by Company	Total
Primary Metal Industries		46,080	193,700	239,780
Printing and Publishing Industries	104,880	97,240	10,510	212,630
Rubber and Plastic Products	120	10,300		10,400
Stone, Clay and Glass Products	10,740	2,079,390	98,280	2,188,410
Textile Mill Products			1,920	1,920
Tobacco Manufacturers	42,400	206,450	141,650	390,500
Transportation Equipment	7,850	851,760		859,610
Miscellaneous Manufacturers	1,300	11,670	589,830	602,830
Average	3,562,720	8,852,540	4,652,950	17,068,210

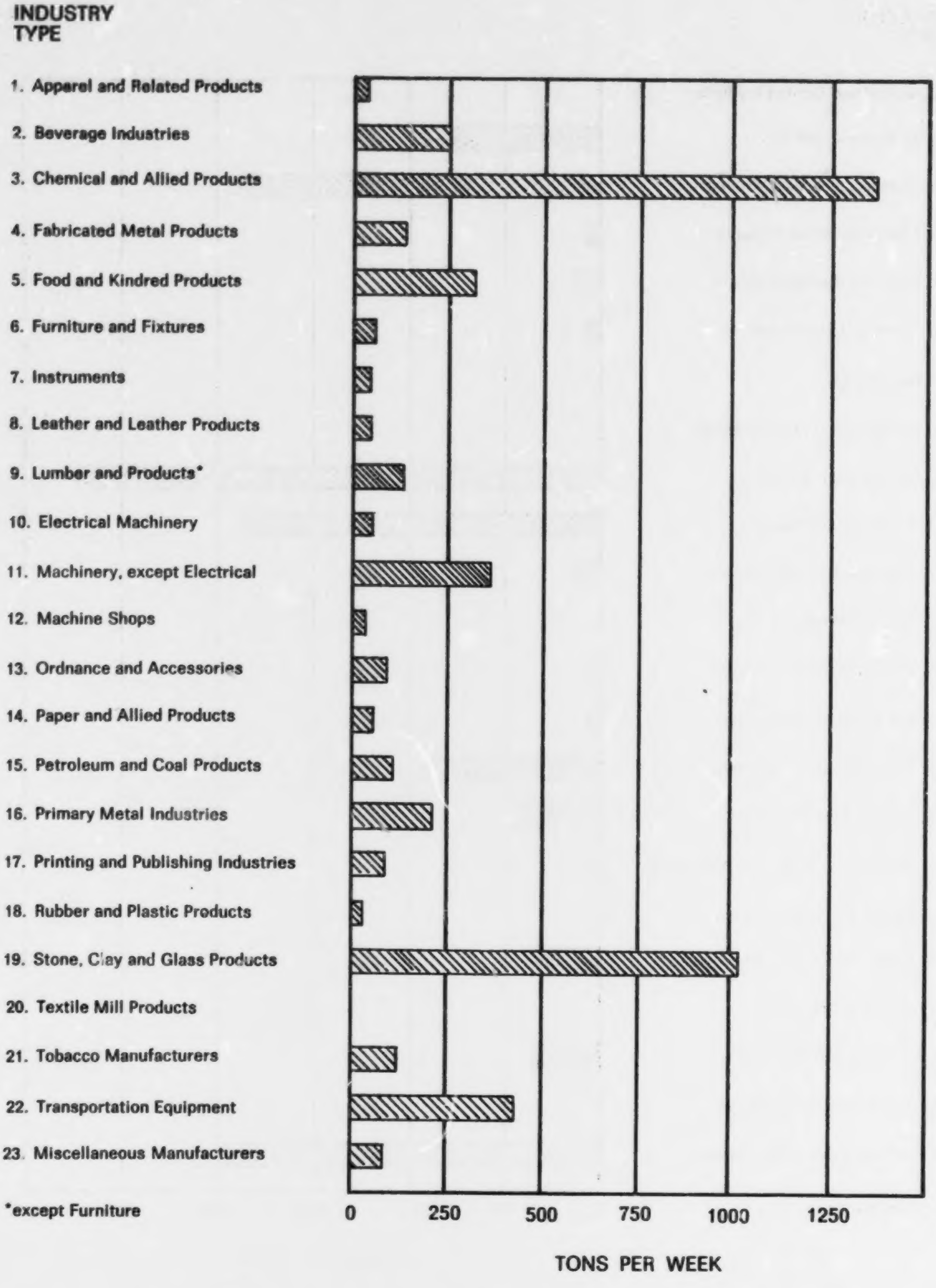


FIG. 35 — INDUSTRIAL WASTE DISPOSED OF BY PRIVATE OR CIVIC HAULERS

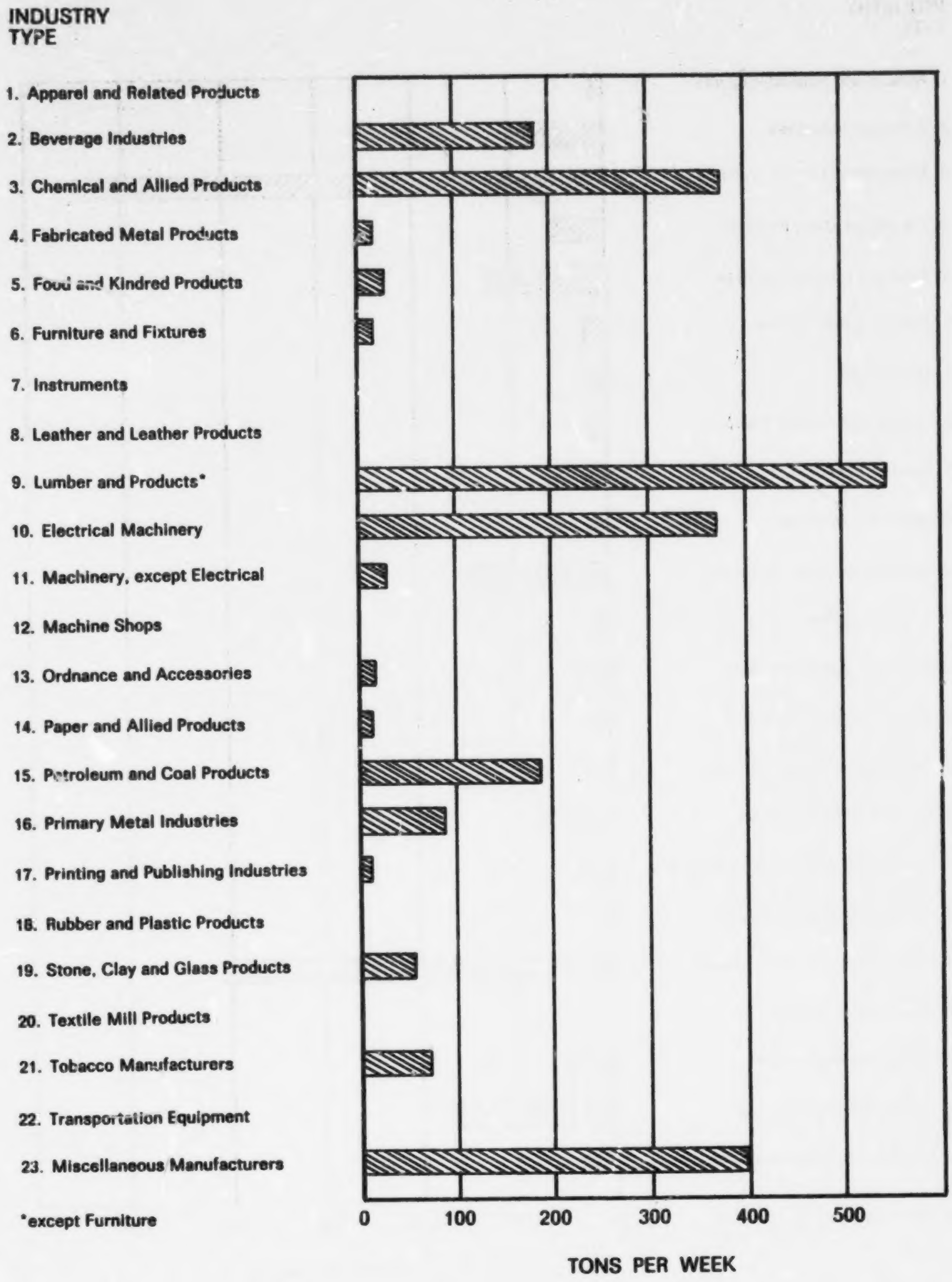


FIG. 36 — INDUSTRIAL WASTE DISPOSED OF BY COMPANY EMPLOYEES

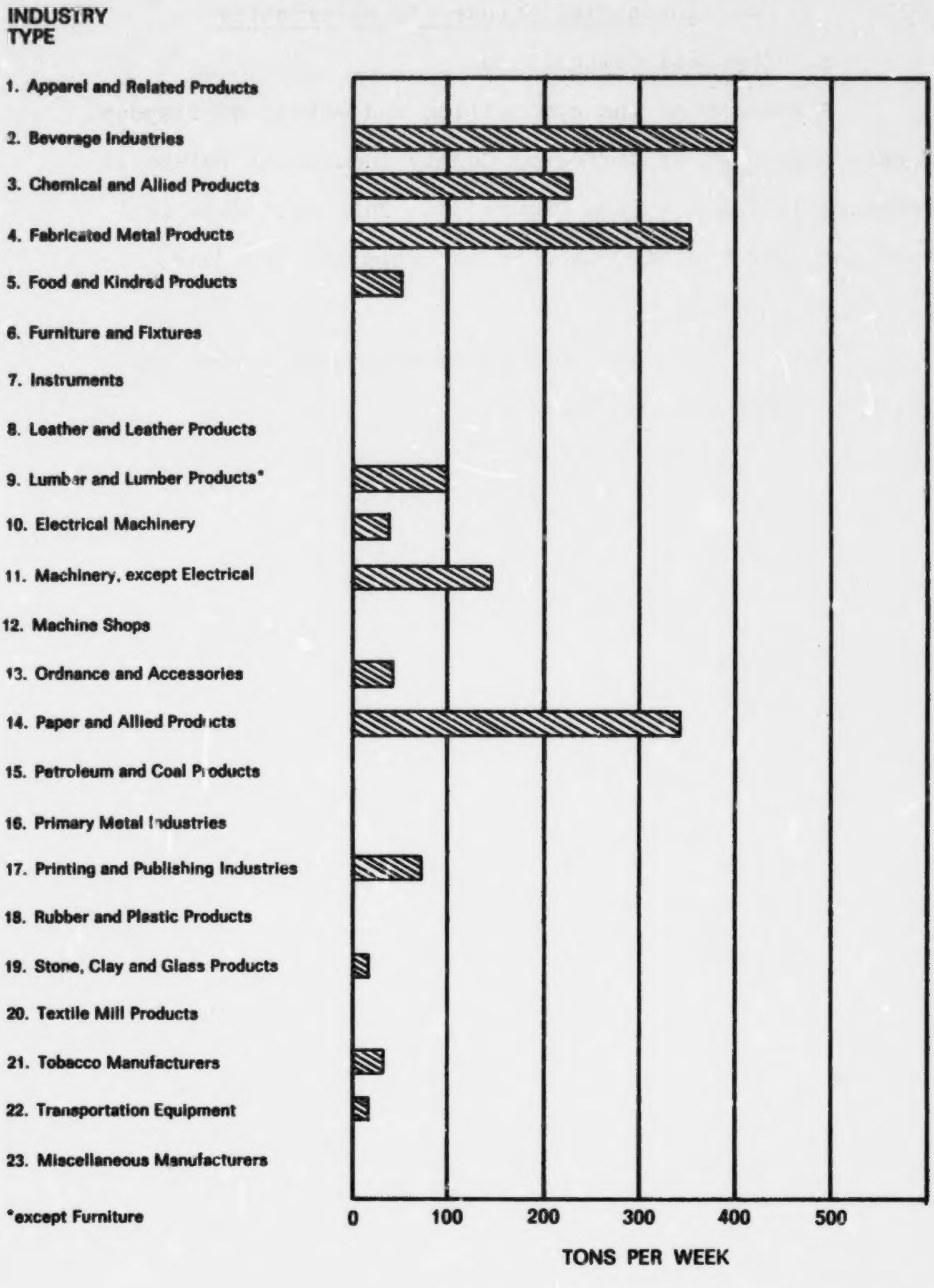


FIG. 37 — INDUSTRIAL WASTES SALVAGED

4. Industrial Refuse Characteristics

a. Physical Composition

A summary of the composition and method of disposal of each component of Jefferson County industrial refuse is presented in Table 23 and Figure 38. This same data is given for each industry type in the Separate Appendix.

b. Density

The wet bulk densities of homogeneous industrial wastes are presented in Table 24.

TABLE 23

Composition and Methods of Disposal of Industrial Waste

% of each Waste Type	Waste Disposed of by: Salvage (%)	Private Hauler (%)	Company Employees (%)	Total (%)
Chemical Waste	.004	2.616	.633	3.284
Foodstuffs	6.553	1.664	.141	8.358
Glass	.004	2.931	.303	3.358
Metal	7.536	.397	.070	8.003
Minerals	2.147	24.622	9.952	36.721
Paper Wastes	6.011	5.126	6.298	17.435
Rubber	.066	.604	.885	1.554
Textiles	.152	.233	.004	.388
Wood	.906	3.608	13.434	17.947
Others	-------	2.847	.225	3.072
Total	23.379	44.648	31.975	100.002

*Percentages represent per cent of total Jefferson County Industrial Refuse quantity.

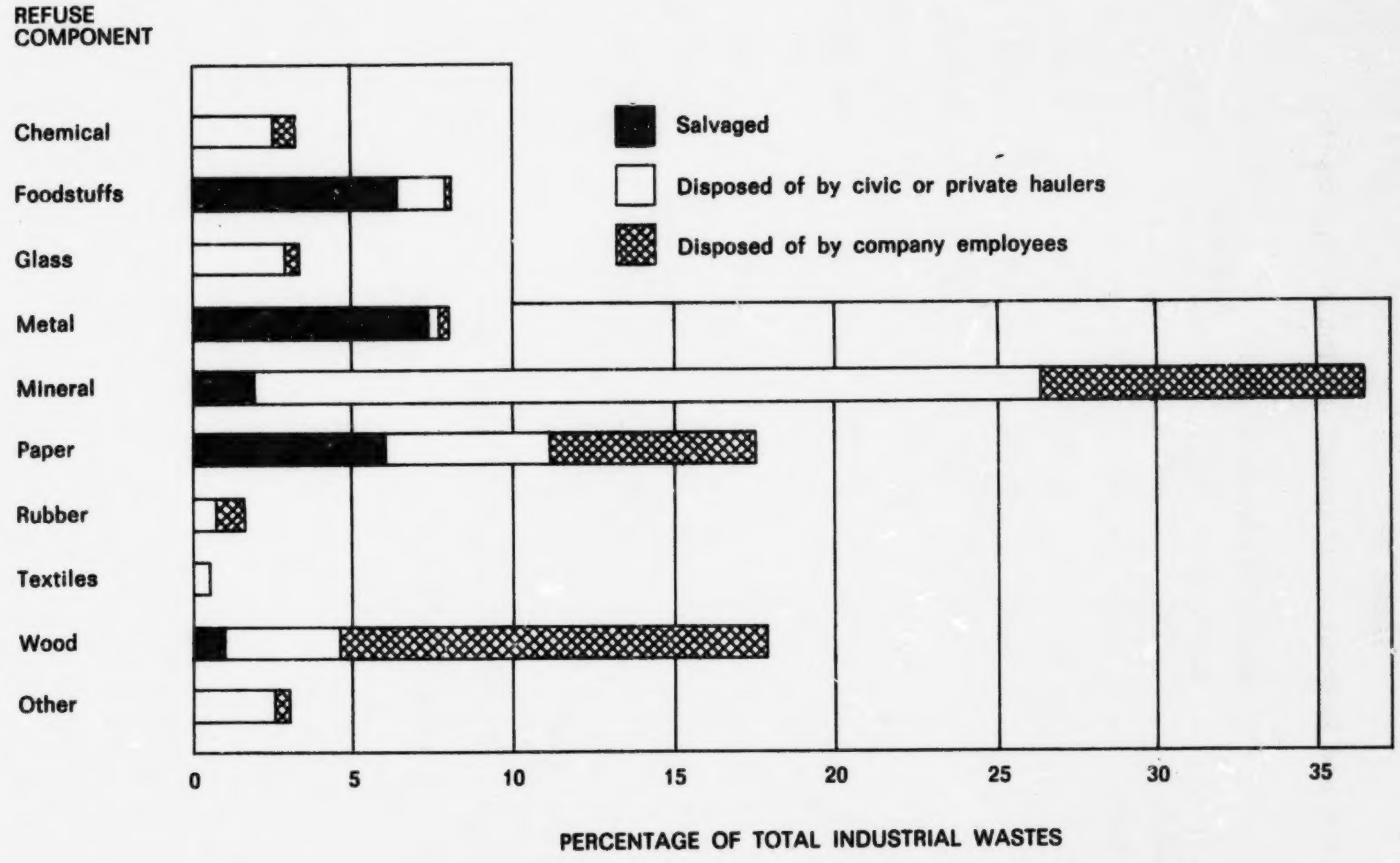


FIG. 38 — COMPOSITION AND METHOD OF DISPOSAL OF INDUSTRIAL WASTE

TABLE 24

Densities of Various Homogeneous Wastes

Type of Waste	Wet Bulk Density Pounds Per Cubic Yard
Foodstuffs	
Brewers Grain, Spent Dried	675-810
Brewers Grain, Spent Wet	1485-1620
Hay or Straw, Baled	648
Heavy Wet Foodstuffs	833
Loose Wet Foodstuffs	505
Restaurant Foodstuffs	505
Glass	
Broken Milk Bottles	979
Broken Soft Drink Bottles	995
Metal	
Copper and Brass (Heterogeneous)	1824
Paint Cans	356
Scrap (Heavy Prepared Steel)	2534
Scrap (Heterogeneous)	635
Shavings (Aluminum)	372
Shavings (Iron)	1635
Minerals	
Ash	1105
Cement	3700
Clay	2284
Coal Ash (Wet)	1483
Slag, Furnace	1431-1755
Stone	3300
Wood Ash (Dry)	1061
Paper	
Baled (Salvaged)	600
Crate (Salvaged)	375
Cardboard	144-630
Industrial Paper Bags, Loose	90
Industrial Paper Bags, Packed	133
Light Industrial Paper Waste (Loose)	56
Miscellaneous Process Paper	142-235
Office Waste	86-179
Plastics	
Miscellaneous Plastic Fixtures	150-300
Plastics, Molded	1500-1693
Wrapping Plastic	62

TABLE 24 (Continued)

Type of Waste	Density Pounds Per Cubic Yard
Textiles	
Miscellaneous Textiles, Packed	300-500
Salvaged Textiles (Baled)	666
Scraps (Loose)	127
Scraps (Tight)	267
Wood	
Blocks (Creosote Covered)	955
Blocks (Small, Loose Pack)	444
Heterogeneous Shapes	310
Lumber (Loose Pack Soft Wood)	271
Lumber (Tight Pack Soft Wood)	374
Sawdust	351
Sticks (Loose Ash)	339
Sticks (Tight Ash)	646
Veneer (Loose Pack)	188
Other	
Heavy Unsalvaged, Sweepings, Rubber, etc.	889

III-E. Municipal Refuse

1. General

Included in the category of municipal refuse are school wastes, junk, street sweepings, sewage sludge, junked vehicles, dead animals, incinerator residue, and park waste. The results of investigations into the quantities of each of these solid waste sources in Jefferson County is reported in this section and are summarized in Table 25.

TABLE 25

Summary of Municipal Refuse Quantities

Source	Quantity	Pounds Per Capita Per Day
Educational Institutions	32 Tons Per Day	0.10
Junk	36 Tons Per Day	0.11
Street Sweepings (City of Louisville only)	37 Tons Per Day	0.24
Sewage Sludge & Grit	180 Tons Per Day	0.46
Junked Vehicles	18,000 Vehicles Per Year	0.23
Dead Animals	17 Tons Per Month	0.04
Incinerator Residue	285 Tons Per Day	N/A*
County Parks & Road Litter	63 Cubic Yards Per Day	0.04

*Note: Already included in domestic per capita values since the incinerator is considered as a transfer facility.

2. Data Collection

The primary source of data for this phase of the study was records maintained by local government agencies. Total refuse quantities were converted to a pounds per capita per day basis for the purpose of estimating future quantities.

3. School Refuse Quantities

Free dumpster service is provided for all elementary and secondary schools within the city limits. Schools outside the city must contract with a private hauler. An estimated 32 tons of refuse is generated daily by Jefferson County educational institutions. Of this total, some 30 tons of wastes are produced in the elementary and secondary schools with the remainder coming from private vocational schools, colleges, and universities. Data pertaining to solid wastes generated by Jefferson County schools is summarized in Table 26.

TABLE 26

Institutional Refuse Quantities

Source	Student Enrollment	Total Refuse Quantity Tons Per Day	Unit Refuse Quantity Lbs. per Student Per Day
Public Elementary & Secondary Schools	167,690	30.4	0.36
Colleges	14,847	2.1	0.28
Total	182,537	32.35	0.354

4. Junk

Based on the Louisville Department of Sanitation records, approximately 21 ± 6 tons of junk is collected each day in the City of Louisville. Scaled up on a per capita basis, this indicates that some 36 tons of junk is collected each day in Jefferson County. Although much of this junk is generated by residential sources, it is not subject to scheduled pick-up and is not reflected in the figures obtained by the domestic refuse sampling program. For this reason, junk was placed in the municipal rather than domestic category.

5. Street Sweepings & Litter

The Street Cleaning Division of the Louisville Sanitation Department periodically sweeps and flushes the city streets and alleys, and also cleans city and private vacant lots. An average of 13,400 tons of refuse is collected annually from these sources. There are no services of this type offered in Jefferson County outside the Louisville city limits, however, the County Department of Public Works does collect an estimated 63 cubic yards per day of litter from county parks and roads.

6. Sewage Sludge

The Metropolitan Sewer District treatment plant in western Jefferson County provides primary treatment for approximately 80 million gallons of raw sewage per day. Stricter water quality standards recently adopted by Federal and state agencies are expected to require secondary treatment of such wastes within the next five years.

The current treatment process yields about 180 tons of sludge and grit each day. MSD estimates indicate an expected 1990 treatment load of some 170 million gallons per day, all of which will undergo both primary and secondary treatment. This will increase the daily sludge and grit volume to approximately 560 tons.

7. Incinerator Residue

This waste is removed from the Louisville incinerator by a contract hauler. Analysis of incinerator data indicates that 0.39 tons of residue is generated for each ton of refuse burned. The average density of the incinerator residue is 1508 pounds per cubic yard.

8. Dead Animals

The Louisville Sanitation Department maintains one vehicle for dead animal pick-up on a call basis. This vehicle also makes daily stops at veterinarian offices, animal clinics, and the city dog pound. Most of the nine (9) tons of dead animals collected each month are taken to a local rendering company, and the remainder are taken to the city landfill. Outside Louisville dead animals are picked up by the Humane Society and the State Highway Department, but there is no special vehicle operated by the county government for this purpose. Dead horses from the three race tracks in Jefferson County are handled by a local dog food manufacturer.

9. Junked Vehicles

Within the Louisville city limits abandoned automobiles are handled by the Safety Division of the Louisville Police Department, and the Auto Theft Branch of the Jefferson County Police Department has responsibility in the county. These two agencies auction off approximately 2200 unclaimed vehicles each year. Most of these auctioned automobiles are purchased by local scrap dealers.

The primary sources of auto wreckers acquisitions of junk autos, as reported in the Bureau of Mines report, "Automobile Disposal - A National Problem", are shown in Table 27.

TABLE 27

Junked Automobile Sources

Source	Per Cent
Individuals	38
Auto and Truck Dealers	26
Insurance Companies	21
State and Local Government Pounds	12
Other	3
Total	10

On the basis of these figures an estimated total of 18,000 junked vehicles are produced in Jefferson County each year.

This figure can be checked by a method widely used for estimating the number of scrapped vehicles. By subtracting the difference in total registrations at the beginning and end of a given year from the number of new vehicle registrations in that year, the number of vehicles not re-registered can be computed. It is generally assumed that this figure represents scrapped vehicles. The results of these computations for Jefferson County vehicle registrations for the past ten years are shown in Figure 39. The average for this ten year period was 27.4 scrapped vehicles for 1000 population or about 18,300 junked vehicles per year. The close agreement of this figure with the quantity based on scrap sources indicates that 18,000 junked vehicles per year is a reasonable figure for Jefferson County. On a weight basis this means that there are 27,000 tons of junked autos generated annually in Jefferson County.

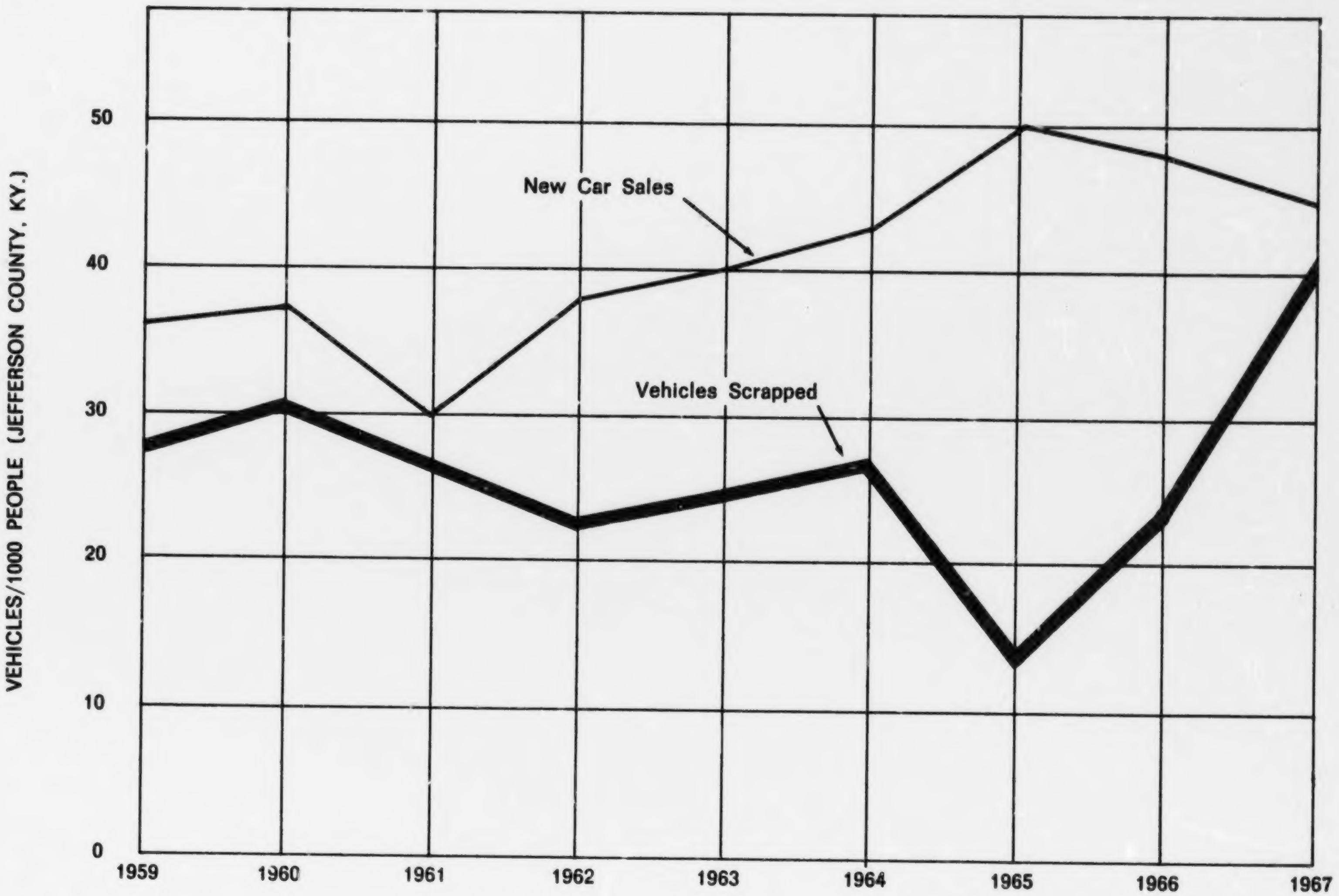


FIG. 39 — JUNKED AUTOMOBILE DATA FOR JEFFERSON COUNTY, KY.

III-F. Construction and Demolition Wastes

1. General

Quantitative data on construction and demolition wastes is the most difficult of all refuse quantity information to obtain. Much of the combustible wastes from these sources is burned on site, and few records are kept on the disposition of such wastes. The only reliable data available was obtained from private refuse haulers serving the larger building contractors with containerized service. This data was converted to a pounds per employee value and this figure multiplied by the total construction employment of Jefferson County to arrive at an estimated quantity for construction wastes. Information on demolition wastes was even more scarce. Even the large wrecking firms do not maintain records of weights or volumes of materials generated. To determine the quantity of demolition wastes generated, the number of buildings torn down annually was estimated and multiplied by a quantity of waste computed for a "standard" building.

2. Construction Wastes

Information was collected on the wastes generated by twenty-four construction firms operating in Jefferson County. Analysis of this data indicated that the average construction employee produces 11.1 pounds of waste daily. On a county wide basis an estimated 85 tons of wastes are hauled away from construction sites each day. This figure does not include the undetermined quantities that are burned on site.

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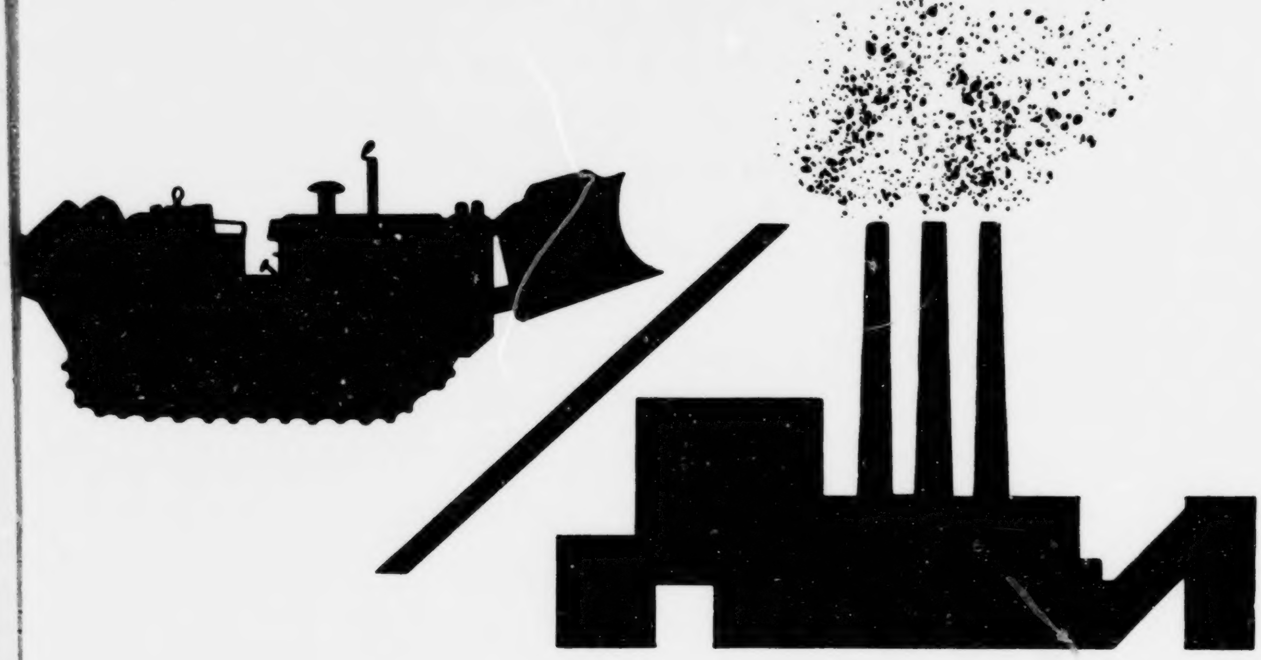
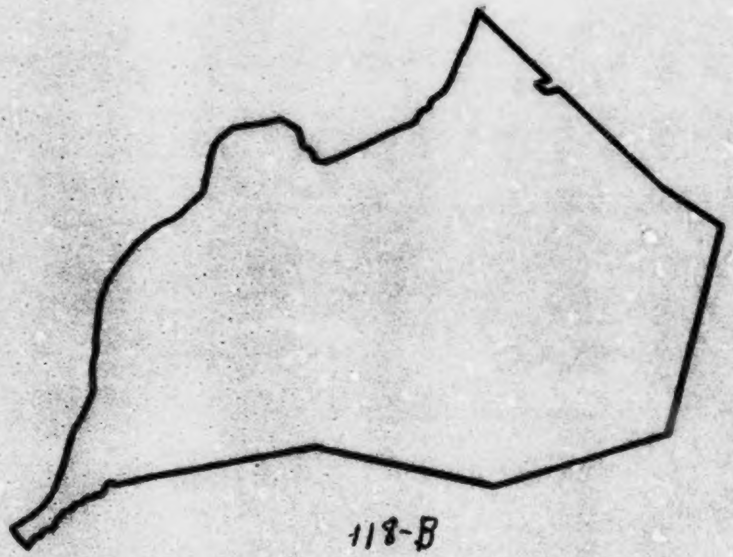
3. Demolition Wastes

Most demolition wastes produced in Jefferson County are taken to dumping locations on private property throughout the county. Substantial quantities of this type waste, particularly concrete, asphalt and earth, are used as fill material on industrial land. Such dumping is not controlled by government regulations, and it was extremely difficult to obtain definitive data on the exact quantities and locations of dumping sites. A very rough estimate of demolition wastes quantities was obtained by estimating the number of buildings to be demolished annually and by personal interviews with local wrecking firms. On the basis of these two information sources it was determined that approximately 400 tons of demolition wastes are generated daily in Jefferson County. The analysis used to derive this Figure is enclosed in the Separate Appendix.

PART IV: ALTERNATE DISPOSAL METHODS





IV. ALTERNATE DISPOSAL METHODS

IV-A. Transfer Stations

1. Definitions

A transfer station is a facility which processes refuse prior to its final disposal at a landfill site. This operation may involve only the transfer of refuse from the smaller collection vehicles into large transfer trucks. It may also involve some form of volume reduction, including shredding, grinding, or baling.

2. Advantages and Disadvantages

Major advantages of transfer stations are:

a. Transfer stations permit more efficient utilization of collection crews by reducing labor time lost in transit to a disposal site;

b. Overall disposal costs can be reduced if it is necessary to locate the disposal sites a great distance from refuse collection areas;

c. Under certain conditions it may be possible to partially offset additional materials handling costs through salvage operations.

Disadvantages of transfer stations are:

a. The refuse must be handled one additional time, increasing requirements for protection from health hazards;

b. Unless operated properly transfer stations can become a source of air pollution and odors, and a breeding place for rodents and insects;

c. Collection and haul schedules must be run within much tighter tolerances to insure efficient operation;

d. Satisfactory transfer facilities are usually expensive, involving relatively high operating costs.

e. Transfer of bulky or unusually shaped materials often requires special facilities.

3. Transfer Methods

There are three general types of transfer e.g. simple, transfer with volume reduction, and transfer with volume reduction and salvage.

a. Simple Transfer - A facility consisting of equipment necessary for transfer of refuse from collection vehicle to transfer vehicle with no provision for any auxiliary handling of the refuse. Typical equipment required includes access roads, fencing, front-end loader, crane, bulldozer, equipment storage, scales, dust and odor controls, and transfer vehicles. Transfer vehicles used are usually large semi-trailer trucks with 50 to 80 cubic yard capacity. These trucks may also include compaction equipment to increase pay-loads, but this is not required. The possibilities of using rail and barge transportation for transfer operations is discussed in another section of the report.

b. Transfer with Volume Reduction - There are a number of volume reduction methods available. The most common are shredding, grinding, and baling. The equipment required for these operations is in addition to that needed for simple transfer. Such equipment, and the skilled personnel needed to operate it, increases transfer costs considerably, making such installations infeasible unless landfill sites are extremely remote or unless landfill space is severely limited.

c. Transfer with Salvage - The high cost of hand separating non-magnetic salvagables from refuse coupled with poor salvage markets, has made such operations generally unprofitable and it was not considered in this study.

4. Costs

The only transfer method investigated from the standpoint of costs was the simple transfer of refuse from collection to transfer vehicle without volume reduction or salvage. Preliminary analyses had indicated that because of the relatively short haul distances involved in Jefferson County, this method, which is the most economical, was the only transfer method with any chance of being economically feasible. A study of the few similar facilities existing in areas similar to Jefferson County indicated average simple transfer costs of $1.25 per ton of refuse handled.

IV-B. Sanitary Landfill

1. Definition

In this report a sanitary landfill is defined as

> "a method of disposing of refuse on land in such a manner that no nuisances or health hazards are created. This involves reducing it to the smallest practical volume, covering it with a layer of earth following each day's operation, and covering the finished site with a final two feet of compacted earth."

2. Advantages and Disadvantages

The major advantages of sanitary landfill are:

a. Sanitary landfill is the most economical method presently available for satisfactory disposition of solid wastes;

b. Marginal lands can be reclaimed by sanitary landfill methods. In some cases the reclaimed land can be used for industrial or residential purposes, in most cases, however, exhausted landfill sites are converted into parks or other recreational areas;

c. Sanitary landfill requires less skilled manpower than many other disposal methods;

d. Air pollution, either from odor or dust, is virtually non-existent;

e. The initial investment is low compared to other disposal methods;

f. A sanitary landfill can handle all types of solid wastes regardless of how bulky or hard to handle;

g. Sanitary landfill is final disposal method; in fact, the only final disposal method available today.

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The chief disadvantages of sanitary landfill are:

a. The difficulty of locating suitable sites near areas of high population density;

b. The difficulty in gaining public acceptance in the vicinity of a proposed site;

c. Settlement of site and generation of gases within the fill can cause problems if buildings are constructed on the landfill site;

d. Extremely wet weather can cause operational difficulties. These can be minimized, however, by proper fill design;

e. If the fill is improperly designed and operated it may become a nuisance and health hazard, and can cause pollution of ground waters.

3. Operational Techniques

There are three different methods of sanitary landfill operation. The three methods are 1) trench, 2) area, and 3) ramp. The method to be used at a particular site is determined by the topography, the position of the ground water table and the availability of cover material.

a. Trench Method - This method is particularly well suited to flat or gently sloping land where the ground water level is not close to the top of the soil.

(1) General Considerations - A trench is excavated and the refuse placed in the trench bottom. The refuse is then compacted in layers and covered with earth excavated from the trench.

The entire excavation should be above the ground water table to prevent ground water contamination. The bottom of the trench should slope away from the point where refuse is being dumped to provide for drainage of rainwater.

The refuse trucks may be unloaded on the bottom of the trench to reduce the amounts of blowing paper and other light materials. This practice requires a much wider trench to permit the movement of trucks to the fill.

(2) Equipment - The type and size of equipment to be used in the excavation, compaction, and covering of the refuse is dependent upon the depth and width of the trench. A bulldozer and front end loader can perform all the needed operations if the amount of refuse coming into the landfill is small. For larger operations a self-propelled crawler crane with a drag bucket may be needed for the excavation. Although compaction and cover can be accomplished with a tracked dozer, a sheepsfoot type compactor unit is preferred, to achieve the highest possible fill densities and extend landfill life.

b. Area Method - The area method is preferred when swamps, abandoned quarries, ravines, and other material lands are to be reclaimed and there is no cover material on the site.

(1) General Considerations - In this type of operation the refuse trucks dump over the active face of the fill. The refuse is compacted and covered with earth hauled from off the site. Compaction is improved by the trucks which usually drive over completed cells to reach the dumping area. The most efficient shape for a cell is square, and all sides of the active fill must be covered daily.

Stockpiling cover material is a common practice, and since the material is usually stored on completed cells of the fill, local consolidation of the refuse will result in the loss of some cover.

(2) Equipment - The only on-site equipment needed to operate a small landfill of the area type is a bulldozer equipped with a special blade designed for handling refuse. In a landfill of substantial size, the use of a cleat-wheeled compaction unit is recommended for spreading and compacting the refuse. Cover for large fills is often spread most economically by self-propelled scraper. The use of a scraper depends on size of fill and individual site condition.

c. Ramp Method - The third method, ramp or progressive slope, is used to reclaim sloping land where cover material is available at the site.

(1) General Considerations - The refuse is dumped on the slope and cover is obtained by excavating just ahead of the active face of the fill. The cover material may also be obtained by scraping the sides of the site if a valley is being filled. The dumping operation can be performed at either the top or the bottom of the active face. Both types of operation have advantages but local conditions will dictate where the refuse trucks should be unloaded. If the fill is close to a residential area or if access is limited, dumping at the bottom is best. The amount of paper and other light materials blowing away is reduced, and the operation can be hidden from public view. Better compaction and less conflict between the hauling and landfill

vehicles are the major advantages to dumping from the top. Better compaction is possible because the refuse trucks are required to drive over completed cells, and traffic conflict is reduced because of landfill equipment will very seldom be required to work on the top of the fill.

(2) Equipment - Equipment requirements are essentially the same as those for the area type fill.

4. Costs

A review of landfill costs for areas similar to Jefferson County indicates an average cost of slightly less than one dollar per ton of refuse landfilled. A number of the landfills included in the survey were not being operated in satisfactory manner and few were being operated in a manner that would comply with the new Kentucky State law governing sanitary landfill operations. Depending upon availability of cover material, costs for a first-class landfill in this area should range from $1.50 to $2.00 per ton of refuse landfilled.

IV-C. Incineration

1. Definition

Incineration destroys or reduces the volume of refuse by relatively high temperature burning. Efficient incineration eliminates the health hazards present in refuse by reducing the putrecible matter to inert ash.

2. Advantages and Disadvantages

The feasibility of incineration as a solution to waste disposal must be determined by evaluation of its advantages and disadvantages.

The major advantages of incineration are:

a. Less land is required than for disposal in landfills;

b. A central location for economic collection of refuse is possible. Incineration can be used to minimize hauling costs as well as extend landfill life;

c. Incineration produces a dense, stable, ash residue which contains a negligible amount of organic material and thus is nuisance free as well as good fill material, if properly used;

d. Modern incinerators can burn many kinds of refuse and can reduce the bulk of some non-combustible materials;

e. An incinerator is not affected by weather conditions;

f. It is possible to produce some revenue with incineration. Waste heat can be used to generate steam or power; salvagable metals and other materials can be sold; direct charges may be obtained for special services to industry;

g. Incineration operation is flexible up to the limiting capacity, and may be varied to handle increases or decreases in refuse quantities;

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h. Reclamation of marginal lands for industrial use takes place within shorter periods of time because the primary settlement of incineration residue occurs much quicker than composting or sanitary landfilling.

The disadvantages of incineration are:

a. It requires an initial capital investment in plant and equipment larger than that needed for other methods of waste disposal;

b. Operation and maintenance costs are high resulting in costs per ton for refuse disposal which is four to six times the cost for sanitary landfill;

c. Skilled personnel are required for efficient, and nuisance-free operation;

d. High costs of air pollution devices may make incineration costs prohibitive. Such devices may increase the per ton costs of incineration by as much as 50%;

e. Incineration is not a complete disposal method. Secondary disposal of ash residue (20% to 35% by weight) must still take place;

f. Many wastes, such as construction and demolition, and some industrial wastes, cannot be incinerated.

3. Operation

Since most large incinerators have many operational similarities, the Louisville incinerator is shown in Figure 40 and will be used as reference in the following discussion.

a. Refuse Receiving, Storage and Handling - Most modern municipal incinerators utilize bin-and-crane type

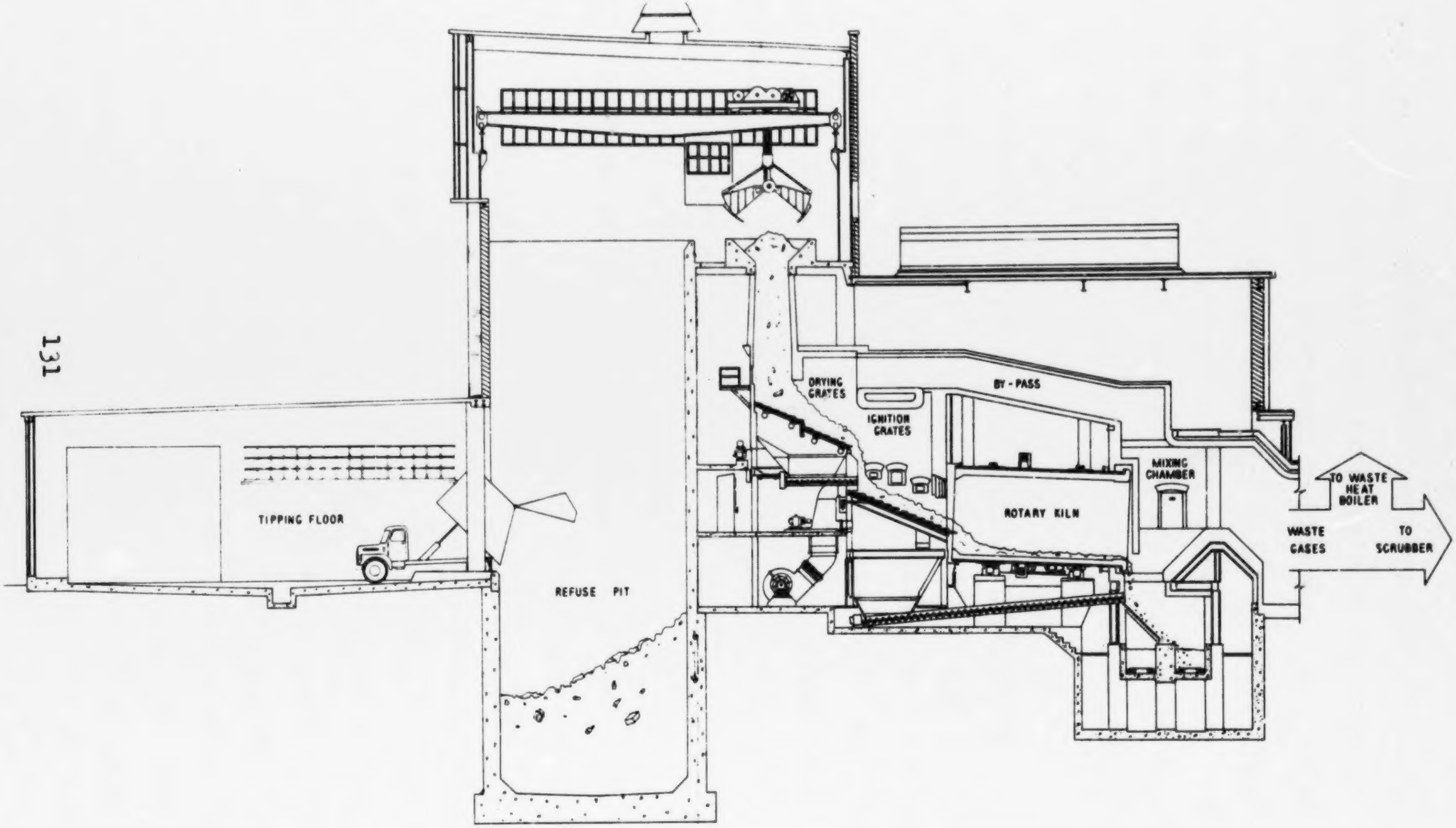

TIPPING FLOOR
REFUSE PIT
DRYING GRATES
IGNITION GRATES
BY-PASS
ROTARY KILN
MIXING CHAMBER
TO WASTE HEAT BOILER
WASTE GASES
TO SCRUBBER

FIG. 40 — SECTION THRU INCINERATOR UNIT

Courtesy of International Incinerators, Inc.

operations, and there are very few floor-dump operations now in use. The refuse is discharged from the collection vehicles into a large pit. Storage pit capacities range from twice incinerator design capacity for plants operating only one eight-hour shift, to slightly more than one day's volume for plants operating continuously. The refuse is removed from the pit by an overhead crane and fed into the incinerator hopper.

b. Refuse Combustion - The refuse passes over the drying grates where excess moisture is removed before entry into the ignition grates where combustion takes place. The Louisville incinerator does not utilize auxiliary fuel for refuse combustion, but many incinerators do require additional fuel to increase volume and weight reductions. The Louisville plant is one of several in this country and Europe that utilizes a rotary kiln to increase the length of time the refuse is exposed to incineration and to improve mixing of the refuse during combustion.

c. Residue Removal - Residue falls onto a drag conveyor which passes through a quench tank before it is carried outside and emptied into trucks. The Louisville plant screens the quenched residue for tin cans and removes other scrap metal by hand.

d. Exhaust Gases - Exhaust gases must be passed through air pollution control devices before release to the atmosphere. The Louisville plant, like many others, uses a baffle spray chamber or scrubber device, that provides minimal pollution control at best. Many of the newer plants are or will be using cyclone separators, filter bags, and electrostatic precipitators to comply with increasingly strict air pollution standards.

4. Costs

Average costs for existing municipal incinerators range from $4.00 to $7.00 per ton of refuse burned including capital amortization. Costs for a new incinerator, at today's prices, and including improved air pollution controls, are estimated to range from $8.00 to $10.00 per ton of refuse burned. An estimate of current costs for the Louisville incinerator, and an average of the costs for five similar plants built in 1960 are shown in Table 28.

Table 28

COST OF REFUSE DISPOSAL BY INCINERATION

Type of Cost	Estimate for Louisville Rotary Kiln Incin. Plant (1964 Costs)	Average of Five Continuous Oper Incin. Plants Built in 1960
Construction Cost Per Ton Per Day of Design Capacity	$3,815	$5,500
Operation:	$ Per Ton	$ Per Ton
Operating Labor and Maint. Labor	1.57	2.93
Overhead & Adm.	.073	.33
	1.643	3.43
Fringe Benefits	-	.97
Supplies	.392	.12
Contractual Services and Maintenance	.351	.38
Amortization**	.80	1.30
Auxiliary Fuel	-	-
	1.543	2.77
Total Costs Per Ton	3.186*	6.20

*Estimate based on 1964-1965 Incinerator Report and Louisville Budget. Latest reported costs for incinerator are $4.32, including amortization.

**Louisville plant amortization based on 1954 construction costs and interest rates.

Other Disposal Methods

1. Composting - Composting is a process in which refuse is permitted to undergo fermentation, changing the putrescible and other degradeable components into organic manure. Such material is commonly used as a soil conditioner and has found wide use in Israel and The Netherlands in reclaiming desert and tidal wastelands. Composting has been attempted on numerous occasions in this country, but the firms engaged in its production have been unable to develop a market for the compost. The major advantage of composting is that refuse, a waste material, is converted into a useable product. There are several serious disadvantages to composting however:

a. The cost is relatively high. Composting costs are comparable to incinerator costs and are from four to six times landfill costs. These high costs are due primarily to the cost of removing non-compostables such as plastics, metals, and glass from the refuse;

b. The cost of mechanically spreading compost is substantially greater than the cost of spreading chemical fertilizer;

c. Compost is only a soil conditioner and has little fertilizer value;

d. Economic conditions in this country make the development of a large compost market unlikely for sometime to come;

e. Several compost plants have experienced serious odor problems, although odors are minimized in a properly designed and operated plant;

f. Non-compostables, which comprise a sizeable fraction of refuse, must still be disposed of, usually by landfilling.

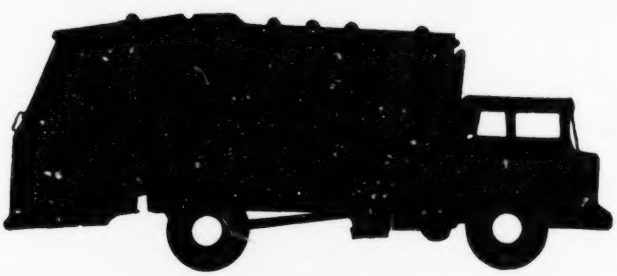
2. Salvage - Reclamation of refuse through salvage should be considered in developing any disposal system. Most often, salvage operation are designed into transfer stations and incinerator plants, and are also used at many compost plants. Materials salvaged are primarily ferrous and non-ferrous metals and paper products.

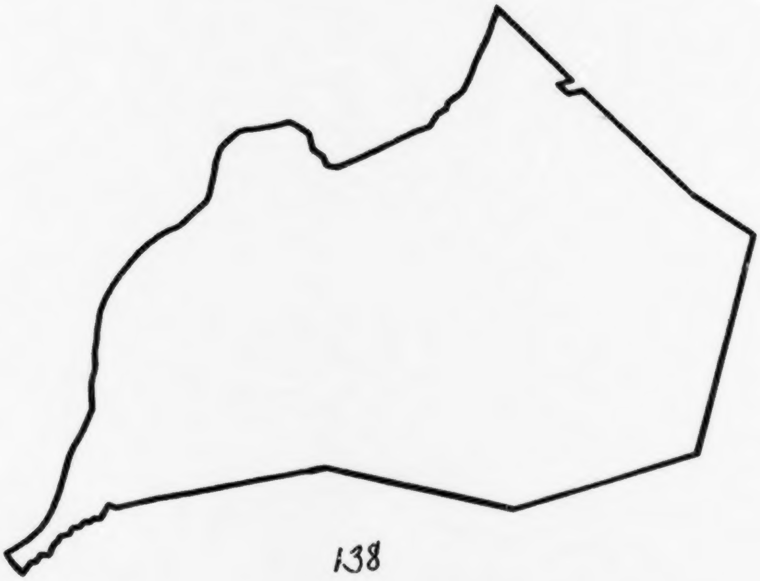
a. Ferrous and non-ferrous metals - the salvage of these materials is usually accomplished through large commercial scrap processing firms. These establishments are equipped with the specialized equipment necessary to transform waste metals into saleable scrap bundles. Some transfer stations and incinerator plants are equipped for limited scrap metal salvage; such as the Louisville incinerator's tin can reclamation. In general, however, the quantities of metal found in domestic and commercial refuse are not great enough to justify a major salvage facility.

b. Paper and paper products - These materials are salvaged by local paper stock companies. There is a ready market for scrap paper and cardboard, and economic salvage of these materials at transfer facilities is a definite possibility. At least one private hauler is experimenting with paper salvage from industrial refuse, and the high paper content of commercial refuse makes this a large source of salvageable paper. The paper contained in domestic refuse is generally too contaminated for salvage, and the salvage of such paper could only be accomplished by separate collection.

3. High temperature destruction - A new approach to incineration, utilizing ultra high temperatures in a type of blast furnance, high temperature destruction (HTD) is being studied by several research groups, and at least one pilot plant installation is in use. This process consists of combustion and fusion taking place within a specially designed vessel at temperatures well above the melting point of noncombustibles normally encountered in refuse. Combustion occurs between 3000 F and 3300 F which is 1200-1500 degrees higher than the combustion temperatures existing in conventional incinerators. The residue from this process is approximately 2% of the initial refuse volume and is in the form of inert slag. Fly ash collected by the air pollution control devices amounts to another 2% of the original volume. High temperature destruction results in a much higher volume reduction, and will handle materials which cannot be reduced by conventional incineration. Although HTD is still in the experimental stage, it could be a major breakthrough in solid waste disposal technology.

PART V: TRANSPORTATION OF SOLID WASTES





V. TRANSPORTATION OF SOLID WASTE

The purpose of this phase of the project was to investigate:

(1) The methods of collecting and transporting refuse which are currently employed in Jefferson County;

(2) Methods of refuse transportation which can now be economically utilized in Jefferson County;

(3) Methods of transportation which at some future date may prove feasible.

A. Collection

1. Domestic Waste Collection

The City of Louisville sanitation department operates a fleet of 46 enclosed compactor type refuse vehicles for the collections of all domestic waste originating within the city.

The trucks are operated six days per week providing curb side pick up of combined refuse twice a week for each residence.

The crew size is generally one driver and two tippers. Each man works a five-day week on a "swing shift" basis, to provide the necessary personnel for the six-day collection week. The trucks are parked in a yard next to the city incinerator. Facilities for the maintenance and operation of the trucks and administrative offices are also located on the lot.

a. Organization

The City of Louisville is divided into three collection districts. Each district has a forman who supervises waste collection within the district.

The number of collection routes in each district is shown in Table 29.

TABLE 29

Central District	13 routes per day
Western District	10-12 routes per day
Eastern District	12-14 routes per day

b. Description of Collection Operation

The individual crew members arrive at the yard between 6:15 a.m. and 6:50 a.m. and the trucks begin to leave the yard at approximately 6:50 a.m. and by 7:15 a.m. all trucks which are operational have left the yard. Figure 41 shows the frequency of the various starting times. After leaving the yard, the truck travels to the starting point of its route where the refuse is collected, and then returns to the incinerator. On the average, approximately three trips are required to service the assigned collection area. After which the crew will normally be through for the day unless assigned other work duries by the supervisor. Figure 42 shows the average number of trucks which complete a day's work at a given time.

c. Size of Loads

On all trips except the last, the truck is filled before returning to the yard. On the last trip the truck will usually be only partially filled since the remaining portion of the route will rarely provide exactly enough refuse to fill the truck. This is demonstrated in Figures 43 and 44 where the frequency of weight per load is shown in the form of histograms.

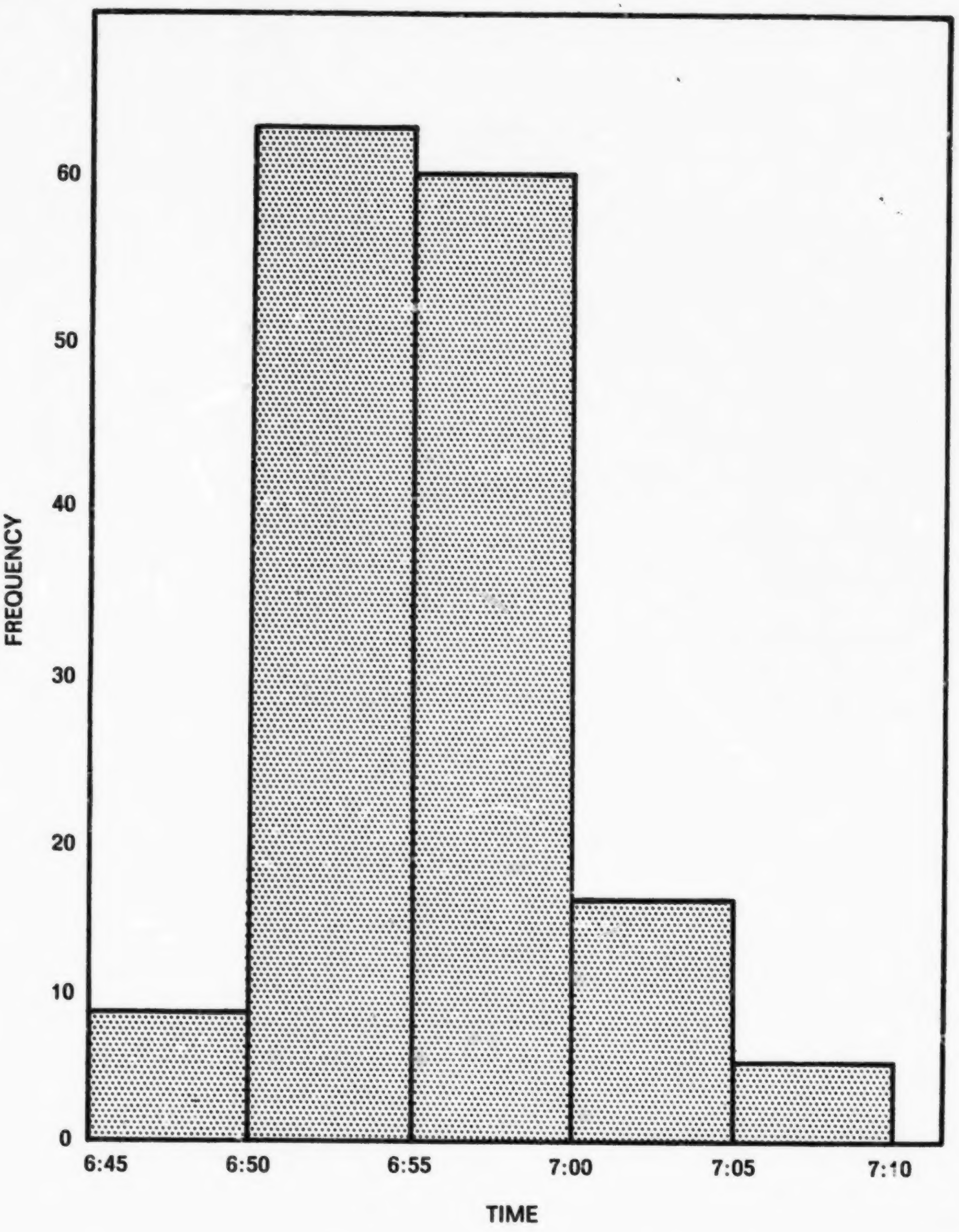


FIG. 41 — HISTOGRAM OF STARTING TIMES FOR COLLECTION VEHICLES

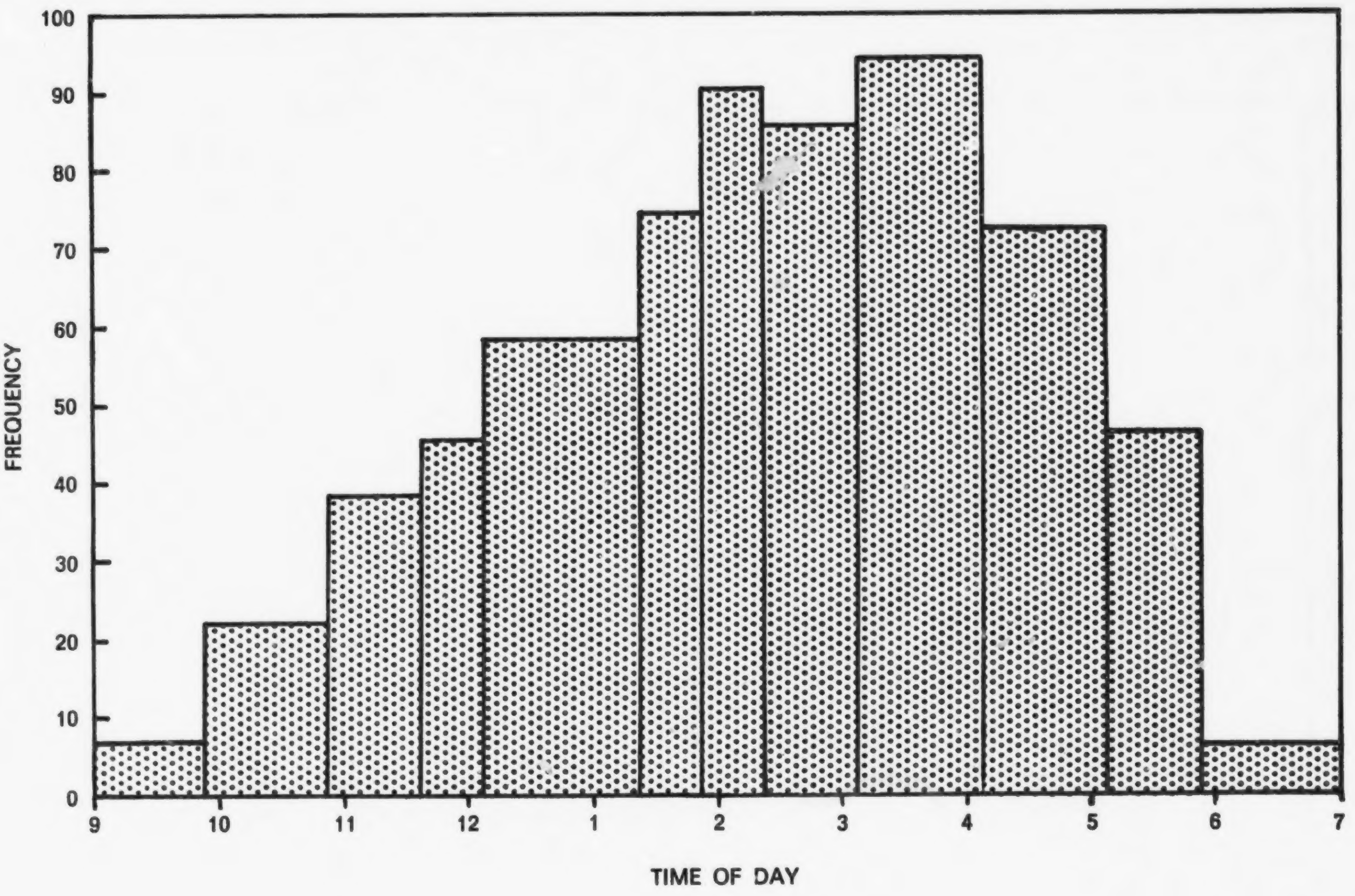


FIG. 42 — HISTOGRAM OF TIME AT WHICH CREW COMPLETES DAYS WORK

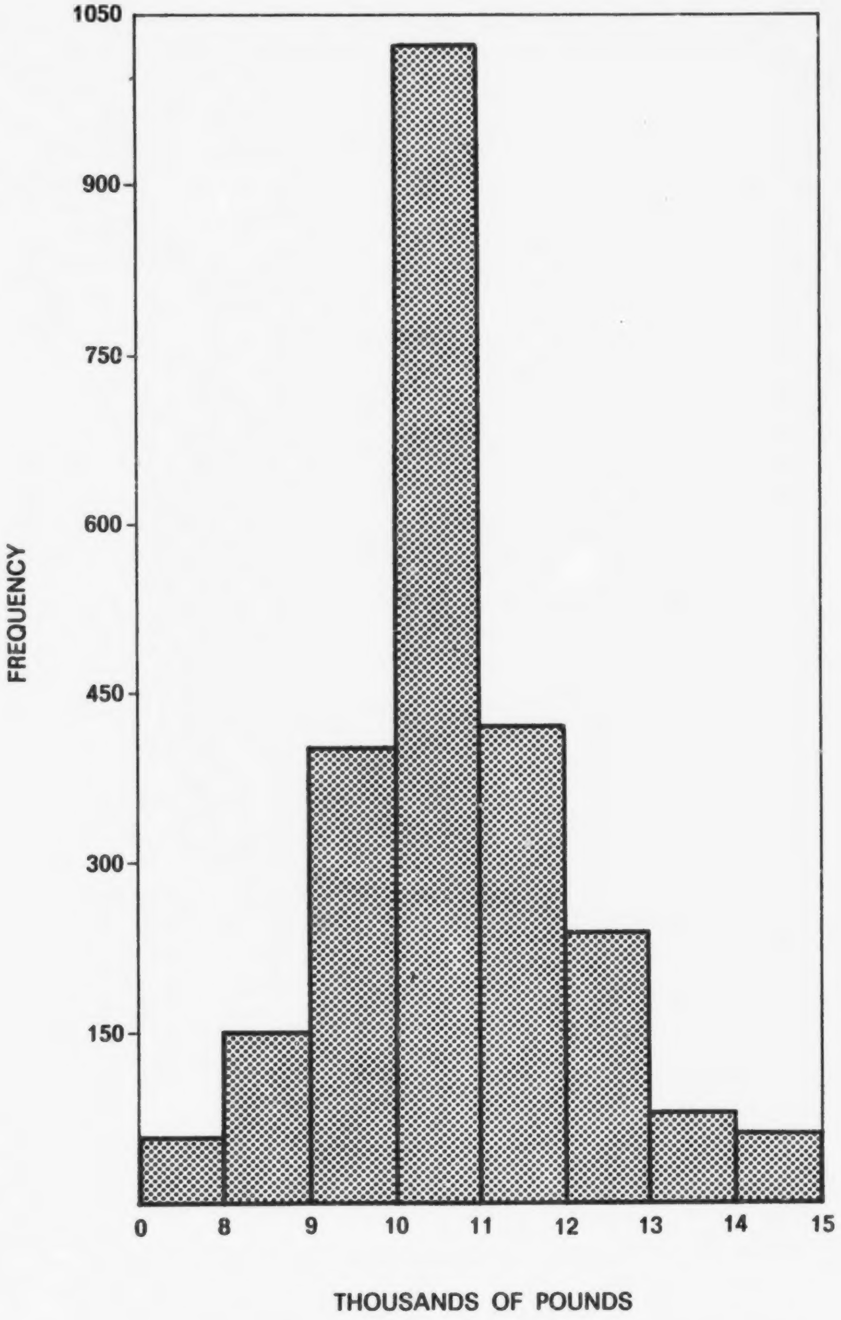


FIG. 43 — FREQUENCY HISTOGRAM OF WEIGHT OF REFUSE HAULED ON FIRST LOAD BY PACKER TRUCKS

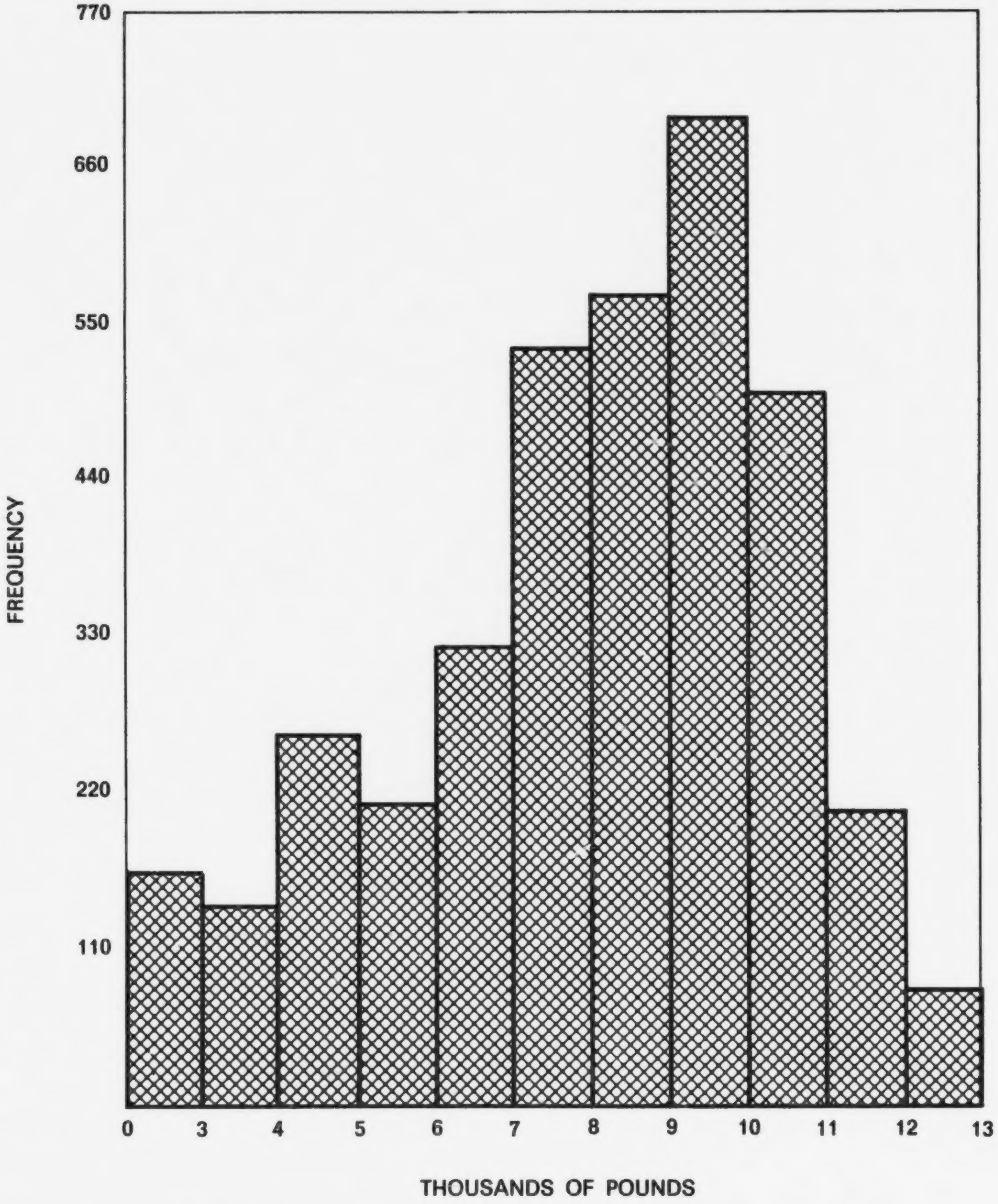


FIG. 44 — FREQUENCY HISTOGRAM OF WEIGHT OF REFUSE HAULED ON LAST LOAD BY PACKER TRUCKS

d. Unit Operations

The collection trip may be broken down into essentially four unit operations.

These operations are pickup, haul, at site, and off route.

(1) Pickup - The pickup operation, or the actual collecting time from the moment the first container is loaded, until the truck is full and ready to start its return trip to the disposal site, comprises the effective working time of the collection crew. The evaluation of this operation may be expressed as the number of minutes per crew member (including driver) required to collect one ton of refuse.

(2) Haul - The haul operation includes the time required to travel to and from the actual collection area. Figure 45 shows a tabulation of truck speed for various haul distances on typical routes within the city. The average truck speed increases with increasing haul distances, since the truck will often travel on an expressway or other thoroughfares when traveling long haul distances. Speeds of up to 50 mph were noted in several instances when trucks traveled on the expressways.

(3) At Site - The unit operation classified "at site" represents the time spent by the collection vehicle at the disposal or transfer site.

"At site times" were observed for the Meriwether Incinerator and are shown in Figure 46 as a histogram.

(4) Off Route - The unit operation classified as "off route" includes all non-productive activity engaged in by the entire collection crew. This includes rest periods, coffee breaks, lunch, etc. Since the crews do not follow

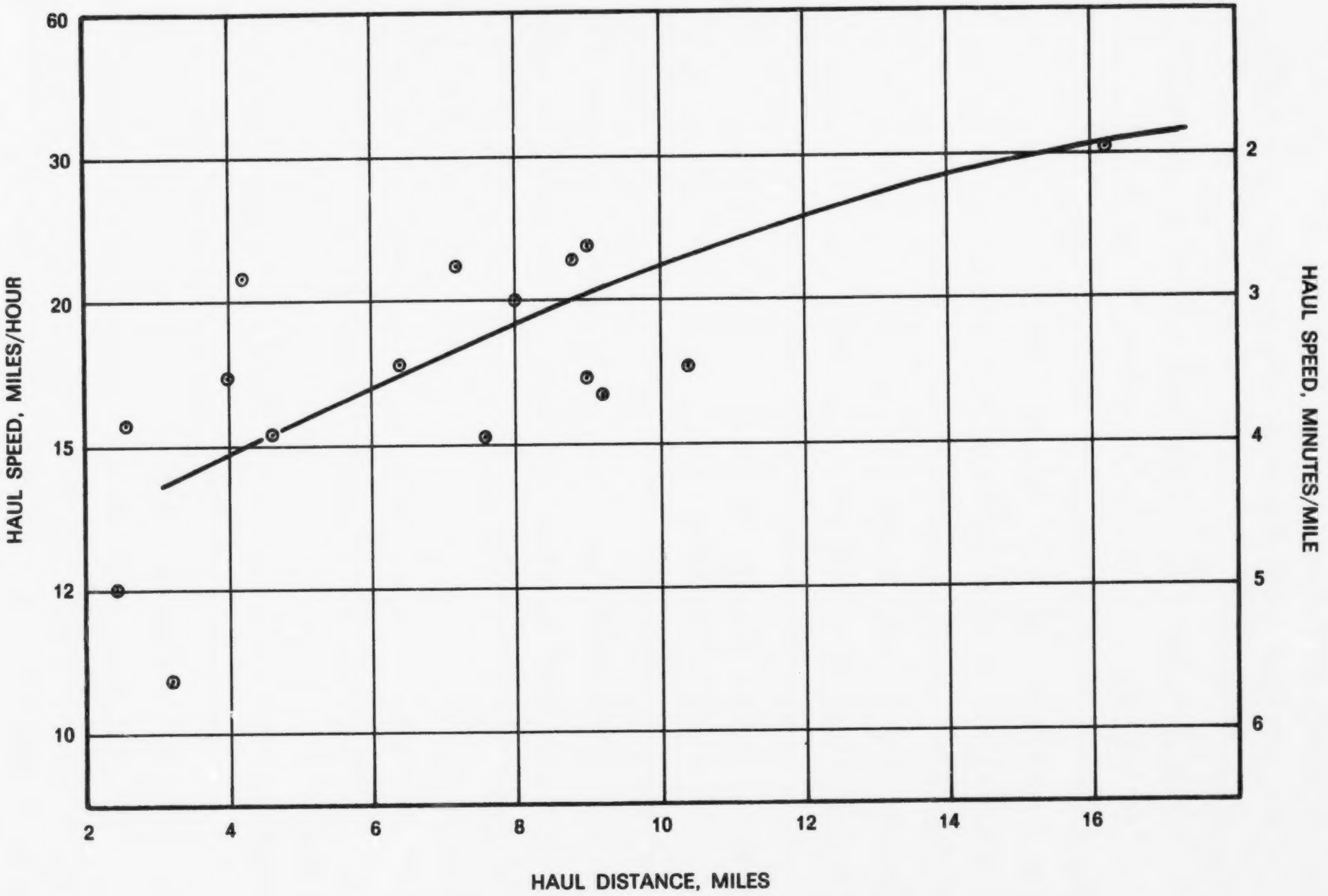


FIG. 45 — VARIATION OF HAUL SPEED WITH HAUL DISTANCE

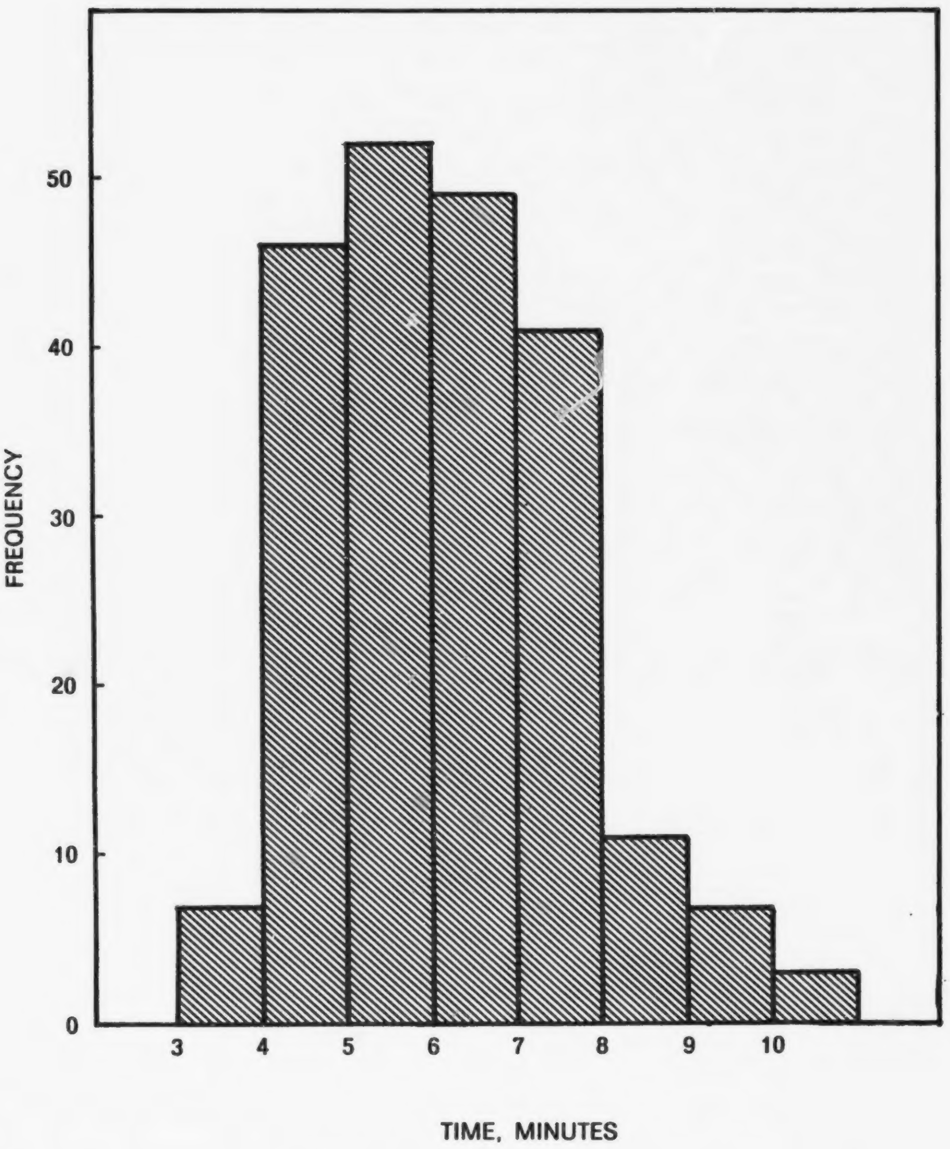


FIG. 46 — HISTOGRAM AT SITE TIMES FOR THE MERIWETHER INCINERATOR

a rigid work schedule, no conclusive data was obtained for the off-route activity.

e. Collection Costs

(1) Labor Costs - The collection personnel work on an incentive basis, that is, if they complete their duties in less than a full work day they are still paid for the remainder of the day. To obtain a realistic picture of labor costs this added incentive pay must be included in the hourly wages of the workers as shown in Table 30 .

TABLE 30

Effective Hourly Wage Scale for Truck Personnel

(Based on 6½ hours worked per day)

Drivers	$2.90
Refuse Collectors	$2.50
Crew	$7.90

(2) Operating Expenses - The trucks used by the Sanitation Department are rented from the City's Public Works Department. The rental fee, however, does not represent the actual operating expense. The average compactor type vehicle has a 20 cubic yard capacity, initial cost of approximately $14,000 and is amortized for a seven-year life expectancy.

The operating expenses for various types of vehicles used by the Louisville Sanitation Department are shown in Table 31.

TABLE 31

Operating Expense for Sanitation Department Vehicles

Type Vehicle	Rental Rate*	True Rate**
Compactor Truck	$4.00/hour	$4.56/hour
Dumpster Truck	$2.25/hour	
1½ Ton Truck	$0.75/hour	
Dump Truck	$0.75/hour	$1.02/hour
Bulldozer	$4.00/hour	$6.23/hour
Passenger Car	$0.50/hour	

*The "rental rate" per hour is based on a 40 hour week even though the truck may be used more than or less than 40 hours per week.

**The "true rate" and the "operating expense" are estimates of the actual cost per hour.

V-B. Transfer Haul

In the next 30 to 40 years the population of Jefferson County is expected to double. At this time local disposal sites will become scarce which will necessitate transporting solid waste to remote disposal points.

To economically transport solid waste over long haul distances requires different modes of transportation than those currently being used. Four possible long haul methods are:

(1) Tractor-trailer units
(2) Rail Transport
(3) Barge Transport
(4) Pipeline Transport

1. Tractor-Trailer Haul

The haul of refuse from the transfer station or incinerator to landfill is done by semi-trailer vehicles having a capacity of from 30 to 80 cubic yards. Such vehicles may or may not utilize compaction devices to increase payload tonnage. The cost of such haul operations generally ranges from $0.15 to $0.30 per ton-mile depending upon the locality being serviced and the specific nature of the operation. To determine the true value of such vehicles with regard to haul operations a cost comparison with the existing system of haul should be made. An example of such a cost analysis follows.

a. Comparison of Semi-Trailer Haul with Direct Haul to the Landfill or Incinerator.

For the purpose of this comparison two systems will be

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considered:

Existing System: Collection vehicles collect refuse and haul it directly to the landfill or incinerator.

Proposed System: Collection vehicles haul to transfer station, tractor-trailer units haul from transfer station to the landfill or incinerator.

To evaluate the two systems a series of cost comparison curves are shown in Figures 47, 48, and 49.

b. Procedure for Cost Comparison

Steps for use of Figures 47, 48, and 49 to determine the feasibility of tractor-trailer haul and transfer operations use are as follows:

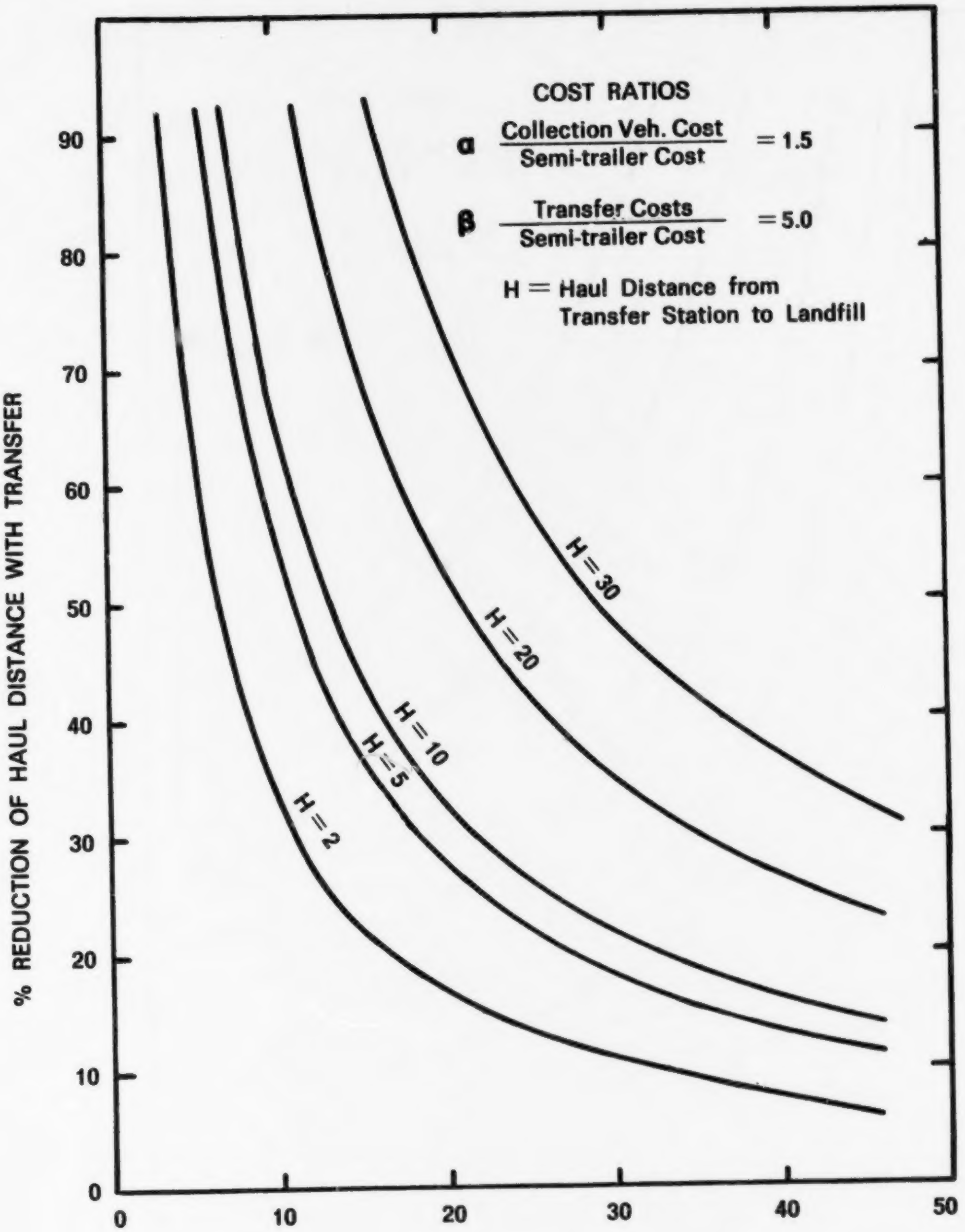
Step 1. Determine the ratio (α) of collection vehicle haul cost ($/ton-mile) to tractor-trailer haul cost ($/ton-mile).

Determine the ratio (β) of transfer cost ($/ton) to tractor-trailer haul cost ($/ton-mile).

Select the appropriate Figure for these values of α and β.

Step 2. Estimate the reduction in haul distance for the collection vehicles from collection area to transfer station. (Example: Collection vehicles now haul an average of 10 miles to landfill after construction transfer station, and collection vehicles will haul an average 2 miles to the transfer station then the per cent reduction will be

$\frac{10-2}{10} \times 100\% = 80\%$.)



HAUL DISTANCE TO LANDFILL VIA COLLECTION VEHICLE, MILES

FIG. 47 — COST COMPARISON OF TRACTOR-TRAILER TRANSFER VS. DIRECT HAUL BY COLLECTION VEHICLES

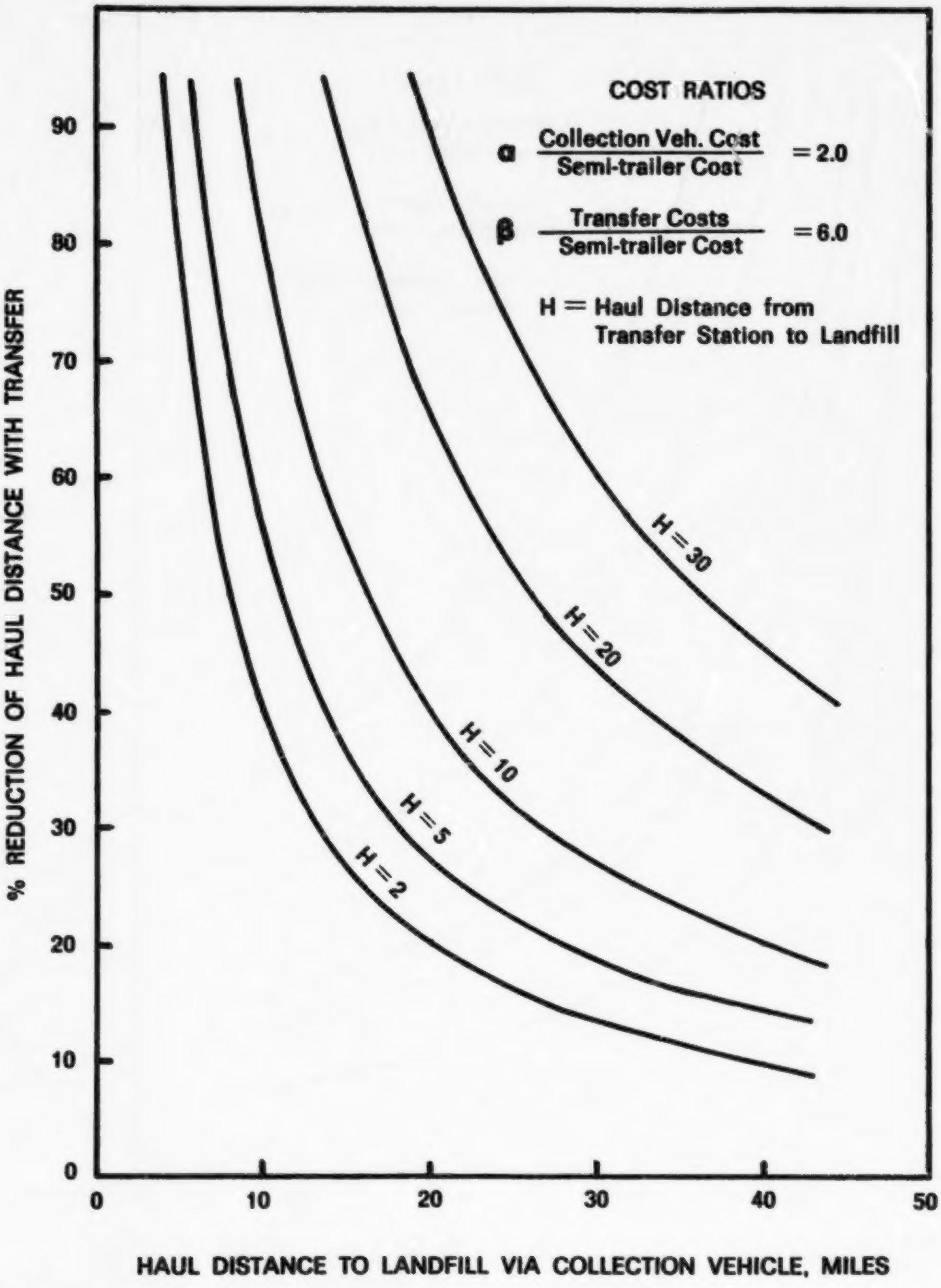


FIG. 48 — COST COMPARISON OF TRACTOR-TRAILER TRANSFER VS. DIRECT HAUL BY COLLECTION VEHICLES

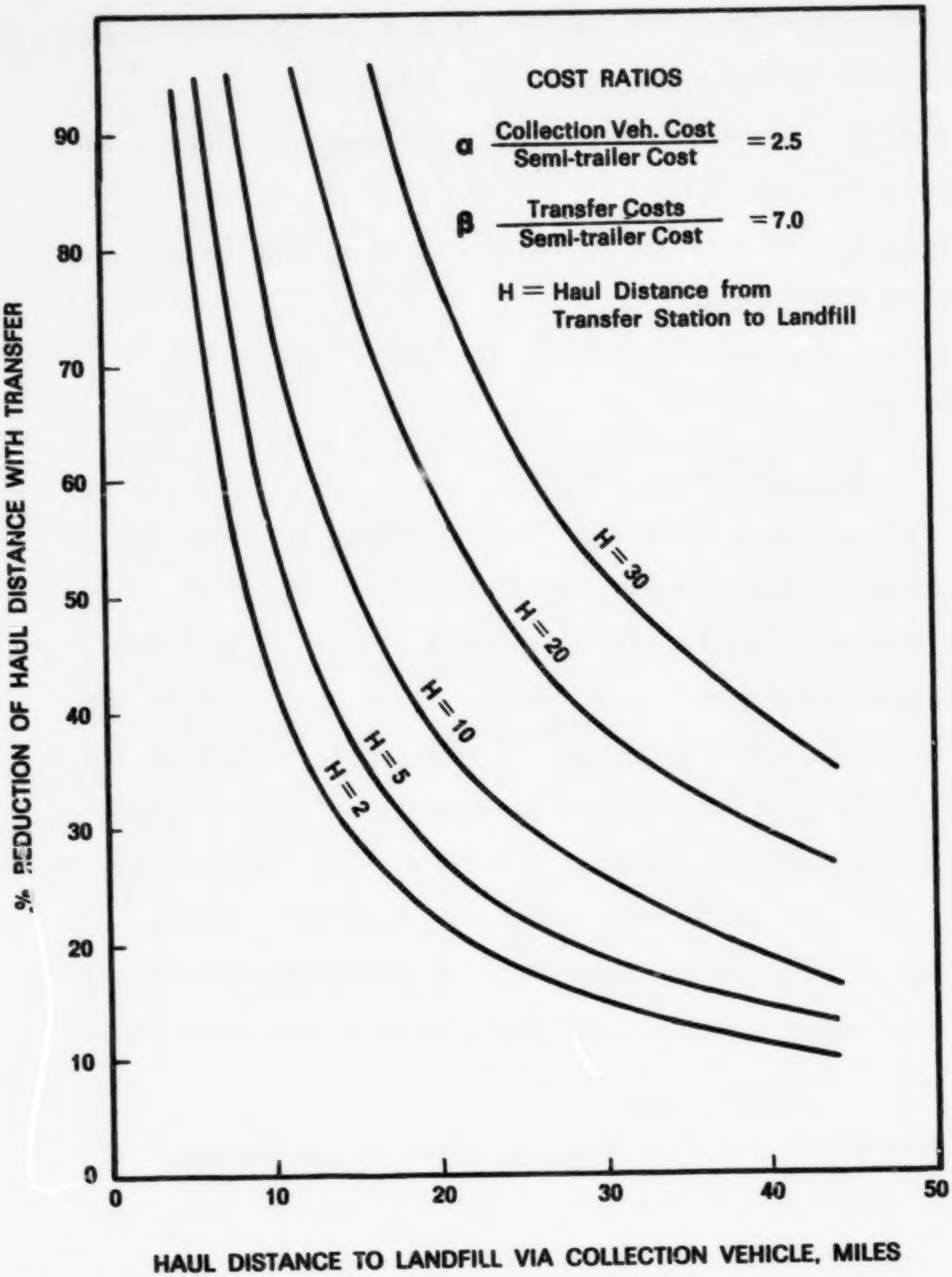


FIG. 49 — COST COMPARISON OF TRACTOR-TRAILER TRANSFER VS. DIRECT HAUL BY COLLECTION VEHICLES

Step 3. Estimate the average one way haul distances from the proposed transfer station to the landfill and select corresponding curve on the chart for this distance.

Step 4. Establish a point on the chart for the values obtained in (1) and (2).

Step 5. Point lies above the curve (found in 3) indicates transfer is economical.

Point lies below the curve indicates transfer is uneconomical.

2. Rail and Barge Transfer

Rail and barge transfer both require one extra handling step which increases overall transfer costs. The only rail transfer contract now in effect is at a price of $5.39 per ton of refuse transferred and hauled. Although there is no barge transfer now in operation in this country, barging could be competitive with rail haul in many instances. Neither method will become economically feasible until landfill sites are only available at extreme distances from the refuse source. These two methods also offer a possible alternate to incineration when available landfill space is severely limited.

3. Pipeline Transport

Several methods have been proposed to facilitate continuous and sanitary removal of solid wastes by pipeline. These include grinding and flushing solid waste into sewer systems, collection of solid wastes by vacuum lines, and slurrying solid waste to be transported in pipelines.

By installing a food waste disposer in each home, the garbage portion of refuse could be practically eliminated. Also the two major community sanitation problems, garbage and sewage, are combined into one, which would be solved at the sewage treatment plant.

About sixty municipalities in the United States have ordinances requiring the use of disposers, including such cities as Los Angeles, California; Detroit, Michigan; and Denver, Colorado, and their respective suburbs. Community use of disposers, however, does not alleviate the huge burden of refuse removal.

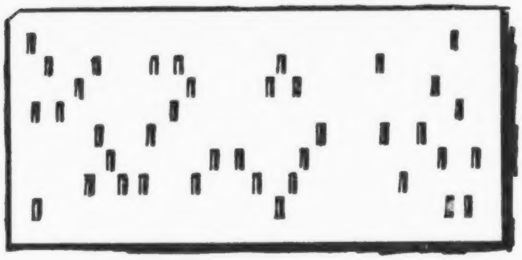
It has been found that a 30 per cent increase in load is an ample design figure for renovating secondary sewage treatment plants to handle ground garbage. Little or no effect is observed on primary treatment devices, since they are designed on the basis of sewage flow.

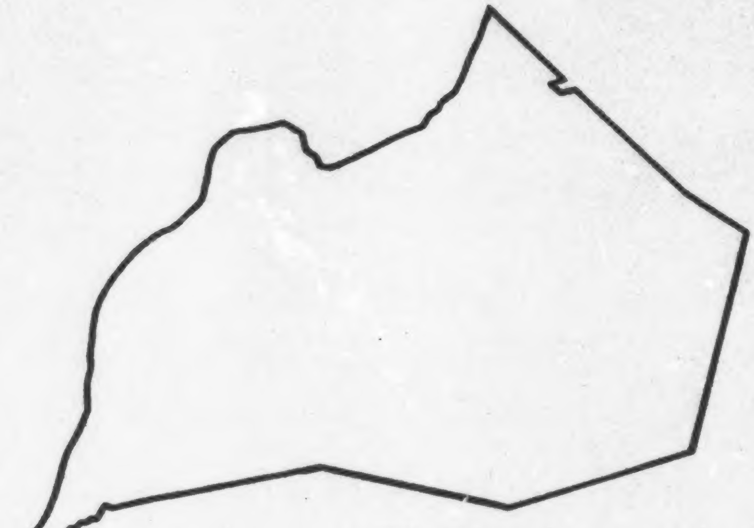
Vacuum collection of solid waste has been operating in a suburb of Stockholm, Sweden, since 1958. A system of ducts connect each home and apartment building to a central collection area where the refuse is drawn by vacuum. The system handles items customarily found in domestic refuse, including large empty glass containers. Refuse is emptied into a chute connected to the vacuum line via a pneumatically operated disk valve. The solid waste is swept along in an air stream of about 90 feet per second mean velocity. The unit was installed to serve nine thousand persons on a hilly 225 acre development site.

Piping of solid waste slurries in pipeline, although not yet in commercial use, is being studied extensively under grants from the United States Public Health Service. Researchers at Pennsylvania State University have found that solid waste slurries of up to 12 per cent by weight can be pumped in pipelines of 2 to 6 inches in diameter.

Whether solid wastes pipelines will be considered as a future means of collecting and removing domestic, commercial, and some industrial solid waste depends largely on its costs as compared with the present packer truck collecting system. Pipeline collection systems may prove feasible in newly developed communities, but it would be very costly to install such a system in an old, primarily urban area.

PART VI: SYSTEM ANALYSIS





15 8-B

VI. SYSTEM ANALYSIS

VI-A. General

1. Requirements of Analysis Method

The primary purpose of this phase of the project was to develop a planning method which could be used to develop a solid waste disposal plan for communities similar to Jefferson County. There were four basic requirements which the proposed planning method had to meet.

The first of these requirements was that the method would permit optimization of disposal and transfer site locations, and would also select the most suitable type of disposal or transfer method. Cost was the only criteria used to determine the optimum disposal system.

In addition to optimizing a disposal system at one point in time, a procedure was developed which predicted future refuse disposal requirements. This permitted optimization on the basis of anticipated as well as current needs. The ability to predict changes in the quantities of refuse produced in a particular area was required since the optimum disposal site locations could conceivably change in response to shifts in the locations of refuse sources.

The third basic requirement was that the optimization technique developed be capable of evaluating future advances in solid waste disposal technology. Since serious research on refuse disposal has only recently begun on a large scale, the possibility that significant technological breakthroughs will occur is very great. To be of maximum value, the planning method should be flexible enough to permit inclusion of new disposal methods and should not be tied to current disposal practices.

The fourth, and perhaps most important, requirement was that the method be relatively easy to use, but remain accurate enough to be useful as a planning tool. It was not intended for the technique to be capable of computing the precise cost of a particular system, but was designed to permit evaluation of alternate systems and to indicate one system as being more economical than another.

2. Selection of Analysis Method

A solid wastes collection and disposal system (or any other environmental system) is generally quite complex and contains many interdependencies. The need to predict future values for system parameters increases the complexity of the problem considerably.

One of the most significant characteristics of a solid wastes disposal system is the fact that, although unit transportation costs are quite low compared with unit disposal costs, these costs are usually the controlling factor in selecting an optimum system. Because of this and because the actual system was so complex, conventional cost analysis methods were obviously unsuited for use in this case.

It was decided that systems analysis techniques should be employed in developing an optimal solution for current and future solid waste disposal problems, and linear programming was selected as the method which best met the research requirements. This method was reasonably straight forward, and allowed simplification of the problem to include only those elements which were deemed to be of importance in planning.

VI-B. Development of Linear Model

1. Determination of Model Scope

A refuse collection and disposal system can be considered as four basic unit operations. These are

a. Pick-up - This operation is that effort actually spent in collecting the refuse within any particular collection area. In the case of domestic refuse, this includes all that transpires between the time the first refuse receptacle is emptied into a truck until either the assigned route has been completed or the truck is full and ready for the trip to transfer station or disposal site. Commercial and industrial refuse collection involving front or rear-end loaders, and handling a number of small establishments with containerized service is considered in the same manner as domestic pick-up. When servicing industrial and some commercial firms which utilize large containers (either of the familiar dumpster type or the increasingly popular stationary compactors) the pick-up includes only the time and labor necessary to lift the full container onto the truck and deposit an empty in its place.

b. Haul - This part of the total operation consists of two different types of haul: (1) the haul performed by the collection vehicles in transporting refuse from collection area to the transfer station or disposal site; and (2) the haul performed by large transfer vehicles to transport refuse from transfer points to disposal sites.

c. Transfer - A transfer station is a facility which processes refuse prior to its final disposal at a landfill

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site. This operation may involve only the transfer of refuse from the smaller collection vehicles into large transfer trucks. More likely, however, the transfer operation will involve some form of volume reduction. This can include anything from shredding and grinding to incineration. Incineration is considered a transfer rather than a disposal operation since incineration does not provide for total final disposal. While incineration usually produces a much greater volume reduction than other transfer methods, the residue must still be carried to a landfill site.

d. Final Disposal - This is usually a landfill operation, but may be composting or a similar salvage process that transforms the refuse into a useable product.

Since it was the shortage of disposal facilities which precipitated the project, and it was the selection of disposal sites that was of primary concern to local officials, only haul, transfer, and final disposal were included in the optimization model. Hereinafter, these three operations are collectively designated as "disposal". The collection was considered as the pick-up operation only.

2. Description of Model Elements

Each element of the refuse disposal system had to be described in a way that would permit its inclusion into the linear model. These descriptions are as follows:

a. Refuse Sources - The fact that the refuse generated by a metropolitan area is distributed unevenly through the area is obvious; however, in the past this characteristic of solid waste sources has seldom been considered when selecting the most efficient disposal system. Usually an overall per capita figure is determined by dividing the total quantity of refuse generated per unit of time by the total population, and applying this value to the region as a whole. Such an approach would indicate that the majority of the refuse comes from areas with a high population density. Current solid waste research indicates that in a modern industrial community, the average citizen produces about two pounds of refuse per capita per day, that the commercial and industrial enterprises each produce another two pounds per capita per day, and that refuse generated by municipal activities such as schools, street sweepings, etc. can also amount to as much as two pounds per capita per day, for a total of 7 - 8 pounds per capita per day. If this total per capita value were considered to be distributed in the same way as the residential population, the picture would be severely distorted and any refuse disposal system planned on this basis would be far from optimum. To insure selection of an efficient disposal system, it is necessary that refuse sources be depicted as realistically as possible. The fact that a predominately industrial or commercial area, with a small residential population, may produce a far greater quantity of refuse than the average suburban residential area must be included in any optimization method, and it is necessary to define the region in a way which will clearly indicate this condition.

One of the basic assumptions for development of the model was that all refuse generated within any particular collection unit area was considered to be generated at one point within the area. The individual collection units had to be reasonably compact for this assumption to hold, and it was necessary to devise some method of subdividing the county into areas small enough to satisfy this condition.

The collection unit selected for use was the census tract or, in some cases, a group of census tracts. Population figures and other data were already disaggragated. Census tract information is an element in most master planning in the city and county, and provides detailed demographic data for each census tract. These data include, in addition to population figures, the number of people employed by commercial and industrial companies within the tract. Furthermore, a recent study by the Louisville and Jefferson County Planning Commission had made growth projections for residential population and commercial and industrial employment by census tract.

The point within a census tract at which all refuse was assumed to be concentrated was approximately the geometric centroid of the tract. In those tracts within the city the use of this centroid was satisfactory since most tracts were either predominately domestic, commercial or industrial and had a high density of inhabitants or employees distributed evenly throughout the tract. In the county, however, this was not the case. Because of the lower population density, county census tracts tended to be larger and often had most of the population or industry concentrated in only part of the tract. In these cases the centroid of the tract was adjusted to reflect this condition. The development of a rational method for this adjustment was considered unjustified and it was done by judgement only. The amount of refuse generated in each tract was determined by multiplying the population, number of commercial employees, and number of industrial employees by a per capita or per employee quantity. These unit quantities were taken as those reported in Section III of this report.

The value used for domestic refuse generation was four pounds per capita per day. This was a combination of the per capita value representing municipal refuse, junk, construction and demolition wastes, obtained by converting the total quantities from these sources to a per capita value. Lumping household refuse with these other sources is justified on the basis that general refuse of this type is generated throughout the entire area and the amount of refuse produced in any one census tract can reasonably be expected to be proportional to the population of that tract. The major exception to this assumption is the sewage sludge, which amounts to approximately 150 tons per day and is generated at only one point.

The commercial refuse parameter used was five pounds per employee per day, and the daily per employee industrial refuse parameter was twenty pounds per day; the industrial figure represents refuse that must be disposed of, and does not include salvage quantities which amount to an additional five pounds per employee per day. These were the mean values for per employee refuse production and individual values varied quite widely. No attempt was made to refine the model to reflect these variations by considering industry groups or different types of commercial establishments. It was felt that since the primary function of the model was as a planning tool, a more detailed breakdown of refuse sources was not warranted.

Growth factors were developed that enabled estimation of residential, commercial, and industrial populations, by census tract, for any future year, using only the present population and employment figures.

b. Disposal Sites - The locations of transfer stations and landfill sites were computed using the same coordinate system used in selecting census tract centroids. The model was not asked to determine the site locations which were theoretically the most advantageous. Instead, it was asked to pick the best available site from a group of sites which were chosen as being compatible with the overall planning requirements of the community.

Present and planned industrial park areas as determined from existing and predicted land use maps were considered as potential transfer station sites. Such areas would be more agreeable to the average citizen than those located in or near residential area.

Selection of possible landfill sites was coordinated with other community planning agencies. Areas given first priority were those set aside as future green spaces by the Planning Commission. These sites were often owned by the county and were sufficient distances from residential areas, but were generally hampered by poor access.

Marginal lands were also considered as potential landfill sites. These areas are often readily accessible and offer the distinct advantage of turning useless land into something of economic value. There are several areas in Jefferson County which would be ideal industrial or recreational sites if the ground level could be raised six to ten feet. Some of these areas are centrally located and in a few cases are close to industrial areas producing large quantities of refuse.

c. Haul Distances - Determination of haul distances and costs were the third element required to adequately describe the refuse disposal system. Haul distances were computed on the basis of the metropolitan metric (travel restricted to E-W, N-S directions only). This metric is widely used in city planning and is explained fully in the appendix volume.

The coordinate system used for Jefferson County utilized a north-south ordinate axis and an east-west abcissa axis. Coordinates were assigned in a manner which insured that all coordinates in the county would be positive.

d. Costs - Three types of transfer were considered feasible at this time. These were (1) simple transfer;

(2) grinding or shredding; and (3) incineration. Based on the current state of the art, simple transfer costs of $1.25 per ton were used. Although shredding or grinding is technologically feasible, and is being done, the newness of the process means that cost figures are yet uncertain, and it was not considered at this time. Incineration was the only transfer method on which first hand information was available. Based on current operating and amortization costs for the Louisville incinerator, an estimated over-all cost of $4.00 was selected for use in evaluating incineration as a possible transfer method.

An operating cost of $1.00 per ton was assigned new landfill sites on the basis of a review of cost for some 50 landfills in similar areas. The two major landfill sites currently in operation in Jefferson County are privately owned and cost figures were not available. Based on charges to users of these landfills, a cost value of $1.25 per ton was assigned.

It should be pointed out that the type of analysis used, does not require that all costs be actual, only that the cost values used be in the proper proportion to one another. Recent state health regulations governing landfill operations will probably raise landfilling costs to $1.50 to $2.00 per ton.

However, total incineration costs at a new facility would probably be $6.00 to $8.00 per ton because of required air pollution equipment and general construction cost increases. Since the ratio of landfill to incineration costs would thus not be changed the basic solution will not change.

Per-ton hauling costs for collection vehicle operation were estimated and are summarized in Table 32. The ton-mile costs were computed as $0.32 per ton-mile including some off-route time and all time at site. This figure includes labor cost for a three-man crew during the haul operation as well as vehicle operating and capital costs. This value is an average value and no attempt was made to include adjustments for the fact that ton-mile costs vary with haul distance. Investigation of current hauling costs indicated that transfer haul in high capacity trucks should cost about one half as much per unit than haul in the collection vehicles, therefore, for the purposes of this report a value of $0.16 per ton-mile was used.

TABLE 32. COLLECTION VEHICLE HAUL COSTS

Operation	Time (Minutes)	Cost/Trip	Per Cent
Haul	23	$ 6.93	14.9
Off Route	10	3.02	6.5
At Site	6	1.81	3.9
Pickup	115	34.71	74.7
TOTAL	154	$46.47	100.00

Although haul costs are usually given in terms of ton-miles, in the field of solid waste the actual cost for transfer haul might better be described in terms of volume. The fact that transfer operations may reduce the volume of refuse must also be included in a description of a solid waste disposal system. This volume reduction was included in the system description by a reduction in transfer haul costs for refuse leaving facilities where refuse volumes were reduced.

3. Formulation of Model

A mathematical model was developed which described the total system in a form which could be used to optimize the locations and types of disposal sites and transfer stations.

The model selected optimum transfer and disposal sites at any particular point in time. To permit long-range planning for solid waste disposal, it was necessary to develop the plan based on future, rather than present, needs. Once the minimum period for which planning to be done was selected, growth factors were used to predict future refuse quantities for each collection area. A detailed description of the model and the method of model solution is given in the appendix volume.

VI-C. Results of Systems Analysis

1. General

A large number of potential transfer and disposal sites were used in order to provide the optimization program a wide range of choices in selecting the most economical system. Five potential transfer sites near the central city were selected on the previously mentioned basis. The computer programs were written so that an incinerator and a simple transfer station were considered at each site. In the program, and in the following discussion, each odd numbered site represents a simple transfer facility. A total of fifteen general landfill sites were selected for use in the solution, but all are not evaluated in each design interval. As the distance into the future increased, sites were considered which were progressively further from the urban center.

So that a maximum number of sites could be included within the restrictions imposed by the capacity of the IBM 1620-1311 computer system used for this problem, it was necessary to run the model solution in two phases for each design period. For the first optimization attempt, the county was subdivided into twenty refuse generation areas, or sources, by combining census tracts in areas of high population density. The initial run clearly established certain transfer and disposal locations as uneconomical, and these sites were removed from the problem for the second, or revised, optimization. The reduction in the number of feasible sites permitted an increase in the number of refuse source areas to forty-two, which gave a corresponding improvement in portraying the refuse sources accurately. The refuse source areas used in the two optimization runs are shown in Figures 50 and 51 and the projected quantities of refuse for each source area are listed in Tables 33 and 34. The small difference between the totals for each group of refuse sources is because of rounding off errors and does not significantly alter the problem. All transfer and disposal sites considered in this problem are shown in Figure 52.

As previously outlined, the costs used in the analysis were estimated relative costs and not necessarily the actual costs that will apply to these operations in the future.

The relative cost values selected for use in the solution are given in Table 35.

The computer program optimized the refuse disposal system at a particular point in time. For any interval of time such as five years, therefore, the system was actually optimized on the basis of anticipated conditions in the fifth year. For Jefferson County, a design interval of ten years was selected since it was felt this was the maximum period for which any specific system should currently be planned because of anticipated changes in technology or in unforeseeable community growth patterns. The demographic data used to determine the problem input values were based on the 1964 special census of Louisville and Jefferson County; therefore, the time intervals used were 1969-1974, 1975-1984, and 1985-1994.

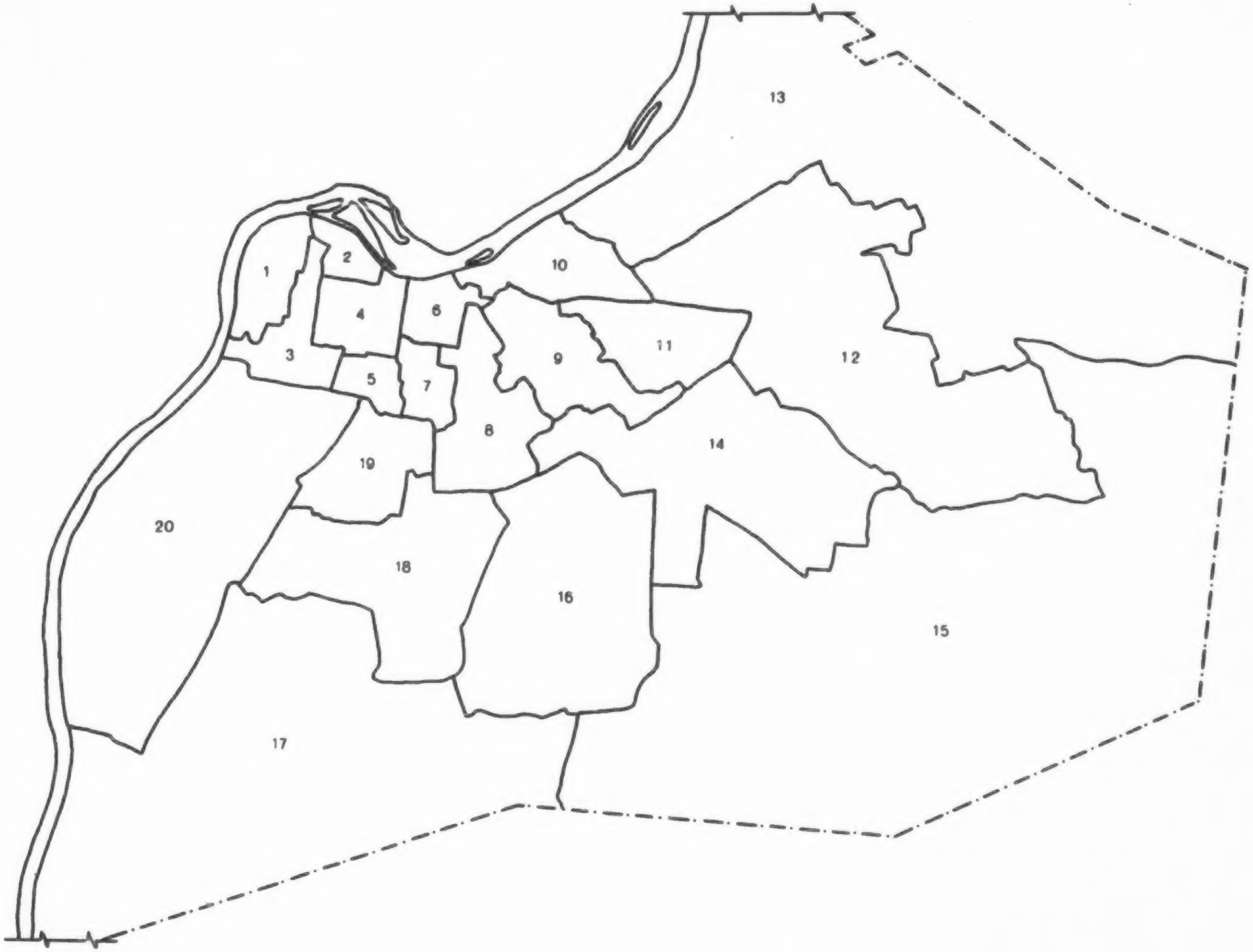

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FIG. 50 — REFUSE SOURCE AREAS USED FOR INITIAL OPTIMIZATION

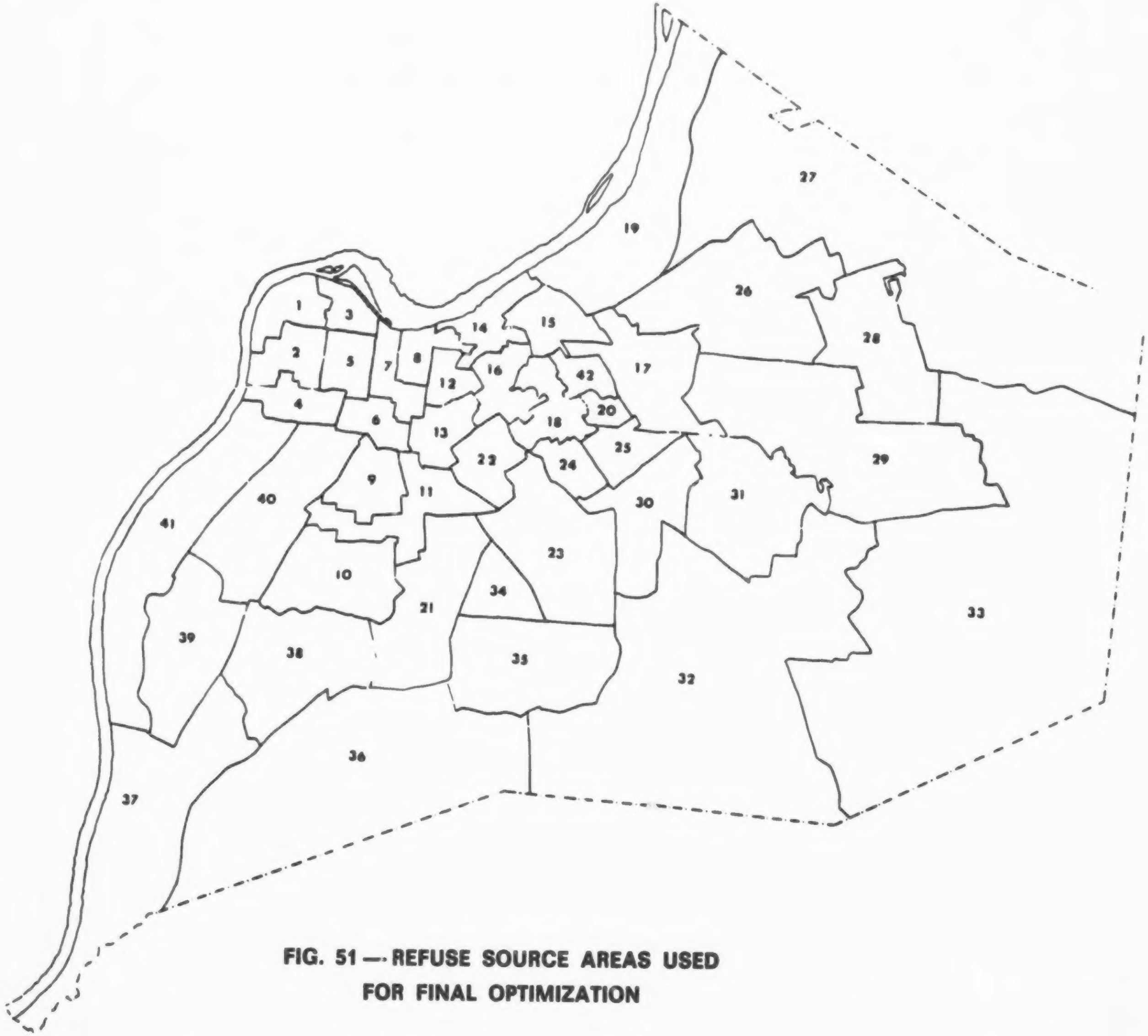
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FIG. 51 — REFUSE SOURCE AREAS USED FOR FINAL OPTIMIZATION

TABLE 33

Projected Refuse Quantities By Source Area

(20 Areas)

Area	Quantity of Refuse (Tons per Day) 1975	1985	1995
Q01	106	109	112
Q02	116	122	129
Q03	170	185	202
Q04	329	364	405
Q05	185	192	200
Q06	185	251	348
Q07	138	152	167
Q08	418	478	547
Q09	120	129	140
Q10	89	96	102
Q11	63	76	92
Q12	224	26	28
Q13	150	170	194
Q14	71	76	81
Q15	145	173	207
Q16	98	203	425
Q17	243	316	421
Q18	189	284	430
Q19	117	149	192
Q20	275	324	383
Total	3231	3875	4805

TABLE 34

Projected Refuse Quantities By Source Area

(42 Areas)

Area	Quantity of Refuse (Tons per Day) 1975	1985
Q01	35	35
Q02	108	114
Q03	77	81
Q04	60	65
Q05	148	159
Q06	154	169
Q07	192	215
Q08	367	423
Q09	96	99
Q10	56	60
Q11	171	184
Q12	101	110
Q13	71	76
Q14	59	63
Q15	36	42
Q16	47	51
Q17	77	87
Q18	34	36
Q19	26	34
Q20	4	5
Q21	129	189
Q22	29	30

TABLE 34 - (Continued)

Area	Quantity of Refuse (Tons per Day) 1975	1985
Q23	89	106
Q24	18	20
Q25	44	45
Q26	66	84
Q27	32	88
Q28	30	44
Q29	31	62
Q30	179	208
Q31	32	41
Q32	83	150
Q33	22	54
Q34	57	66
Q35	44	59
Q36	37	53
Q37	53	62
Q38	24	32
Q39	69	88
Q40	118	128
Q41	85	105
Q42	9	10
Total	3199	3832

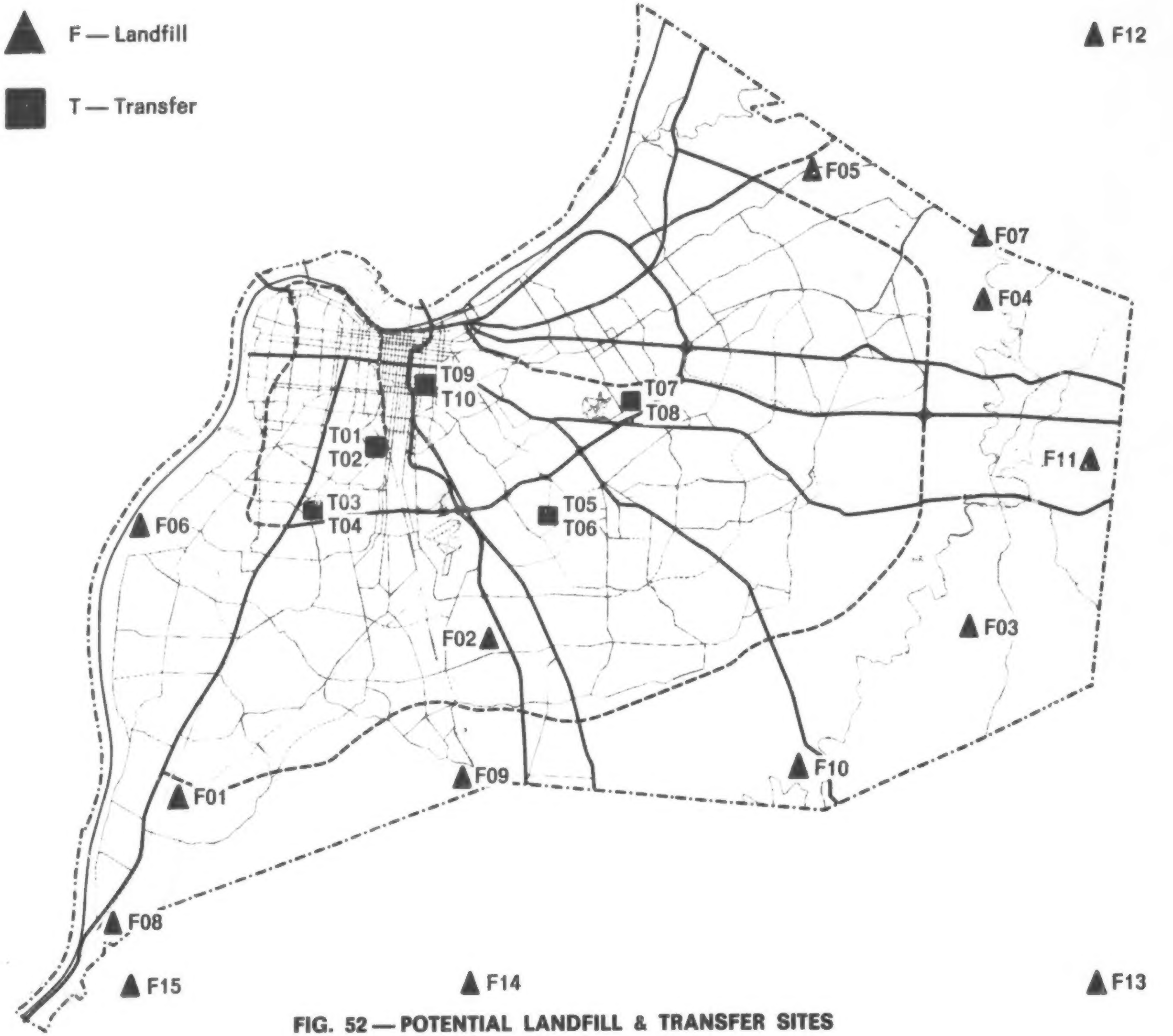

F — Landfill
T — Transfer
F01
F02
F03
F04
F05
F06
F07
F08
F09
F10
F11
F12
F13
F14
F15
T01
T02
T03
T04
T05
T06
T07
T08
T09
T10

FIG. 52 — POTENTIAL LANDFILL & TRANSFER SITES

TABLE 35

Relative Cost Values Used in System Analysis

Component	Cost Value 1975	Cost Value 1985	Cost Value 1995
Landfills			
F01	1.00	1.25	N.U.
F02	1.00	N.U.	N.U.
F03	1.00	1.00	N.U.
F04	1.00	1.25	N.U.
F05	1.00	1.25	2.50
F06	1.00	N.U.	N.U.
F07	1.00	N.U.	N.U.
F08	N.U.	1.00	2.50
F09	N.U.	1.00	2.50
F10	N.U.	1.00	2.50
F11	N.U.	1.00	2.50
F12	N.U.	N.U.	1.00
F13	N.U.	N.U.	1.00
F14	N.U.	N.U.	1.00
F15	N.U.	N.U.	1.00

Table 35 - (Continued)

Component	Cost Value 1975	Cost Value 1985	Cost Value 1995
Transfer Station			
T01	4.00	6.00	6.00
T02	1.25	2.00	2.00
T03	4.00	6.00	6.00
T04	1.25	2.00	2.00
T05	4.00	6.00	6.00
T06	1.25	2.00	2.00
T07	4.00	6.00	6.00
T08	1.25	2.00	2.00
T09	0.05	0.05	3.00
T10	9.99*	9.99	2.00
Haul, Collection Vehicle	0.32 per ton-mile	0.32 per ton-mile	0.60 per ton-mile
Haul Transfer	0.16	0.16	0.20
Haul, from Incinerator	0.06	0.06	0.07

*A high value was assigned the transfer station at the city incinerator site to prevent any refuse from being sent to the transfer station.

2. Results, 1969-1974

For the 1969-1974 period, the initial optimization run considered transfer sites T01 through T10 and landfill sites F01 through F07. In all runs a maximum daily loading of 750 tons of refuse was forced to pass through the incinerator, since it was assumed that this facility would remain in use beyond the final design year of 1995. Earlier trial runs had established the fact that, at its currently estimated relative cost of 4.00 per ton of refuse burned, the city incinerator was not competitive with landfill. To force the system to utilize the incinerator to capacity an extremely low cost value of 0.05 per ton was used.

The results of the systems analysis for the five year period, 1969-1974, are summarized in Table 36 and the allocation of the refuse from each source to the most economical disposal site is shown in Figure 53.

TABLE 36

Refuse Allocations - 1969-1975

Transfer or Disposal Site	Amount Allocated (tons per day)
T09	750
T10	0
F01	161
F02	1996
F05	295
F06	750

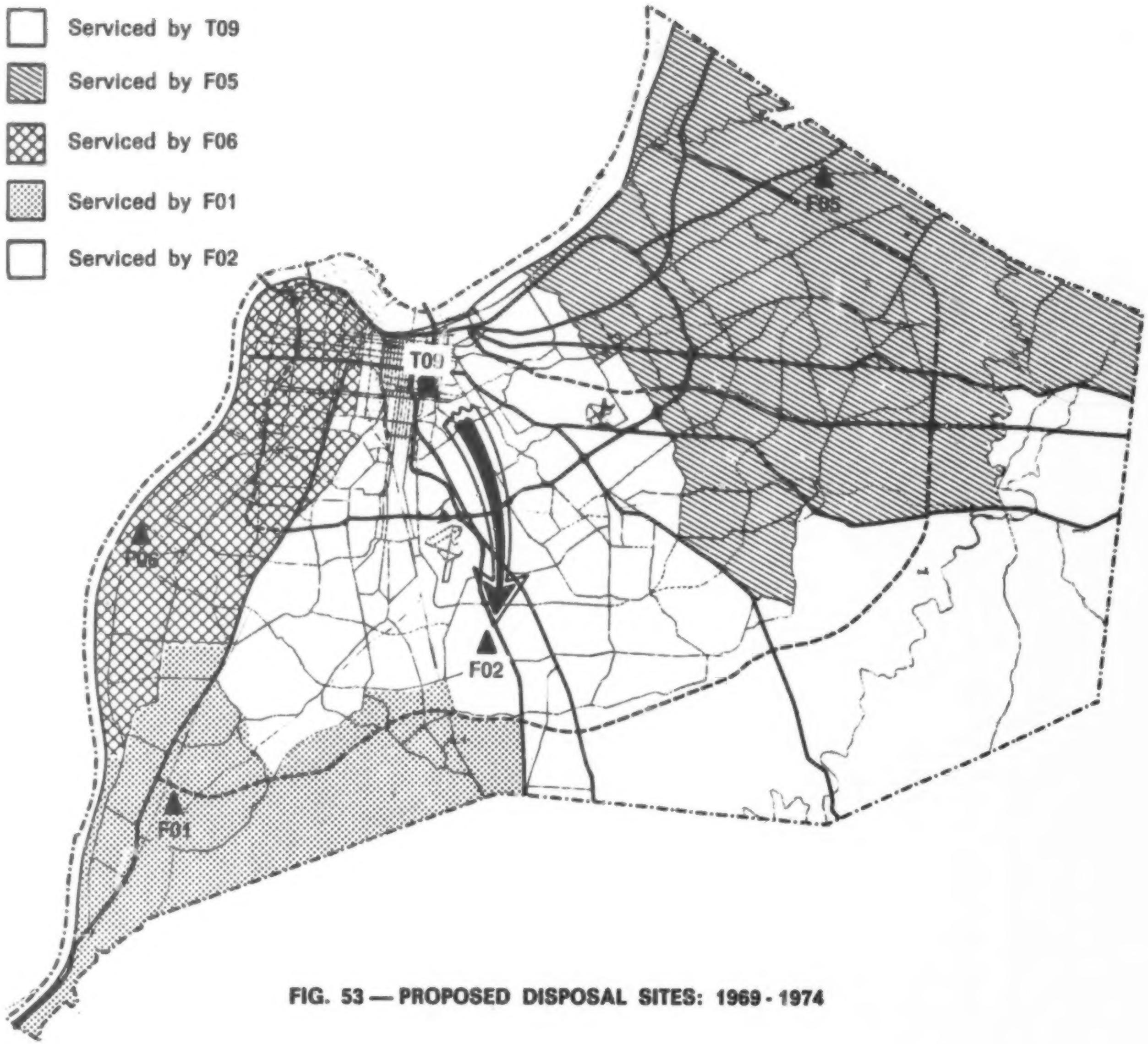

Serviced by T09
Serviced by F05
Serviced by F06
Serviced by F01
Serviced by F02
T09
F05
F06
F02
F01

FIG. 53 — PROPOSED DISPOSAL SITES: 1969 - 1974

3. Results, 1975-1984

The initial optimization run for the 1975-1984 period considered transfer stations T01 through T10 and landfill sites F01, F03, F04, F05, F08, F09, F10 and F11. Landfill costs were slightly increased for sites that were nearer populated areas. Relative transfer costs were increased to 5.00 per ton for incineration and 2.00 per ton for simple transfer because of inflation and anticipated increased pollution control requirements. The same sites and capacity limitations were used for the transfer stations as were used for the 1969-1974 period, however the landfill sites were changed considerably. The high rate of useage for landfill F02 indicated that any site in this area would be completely filled by 1975, and it was removed from further consideration. Sites F06 and F07 presented active landfills which would probably be exhausted by 1975, and therefore were not used for this design period. New sites, F08 through F11 were selected to replace F02, F06, and F07. They were positioned at the extremities of the county since it is expected that suburban expansion will have eliminated any sites closer to the central business district.

The transportation relative costs for the previous period were assumed to apply in this case.

The results of the optimization for 1975-1984 are listed in Table 37 and the areas of the county serviced by each facility are shown in Figure 54 .

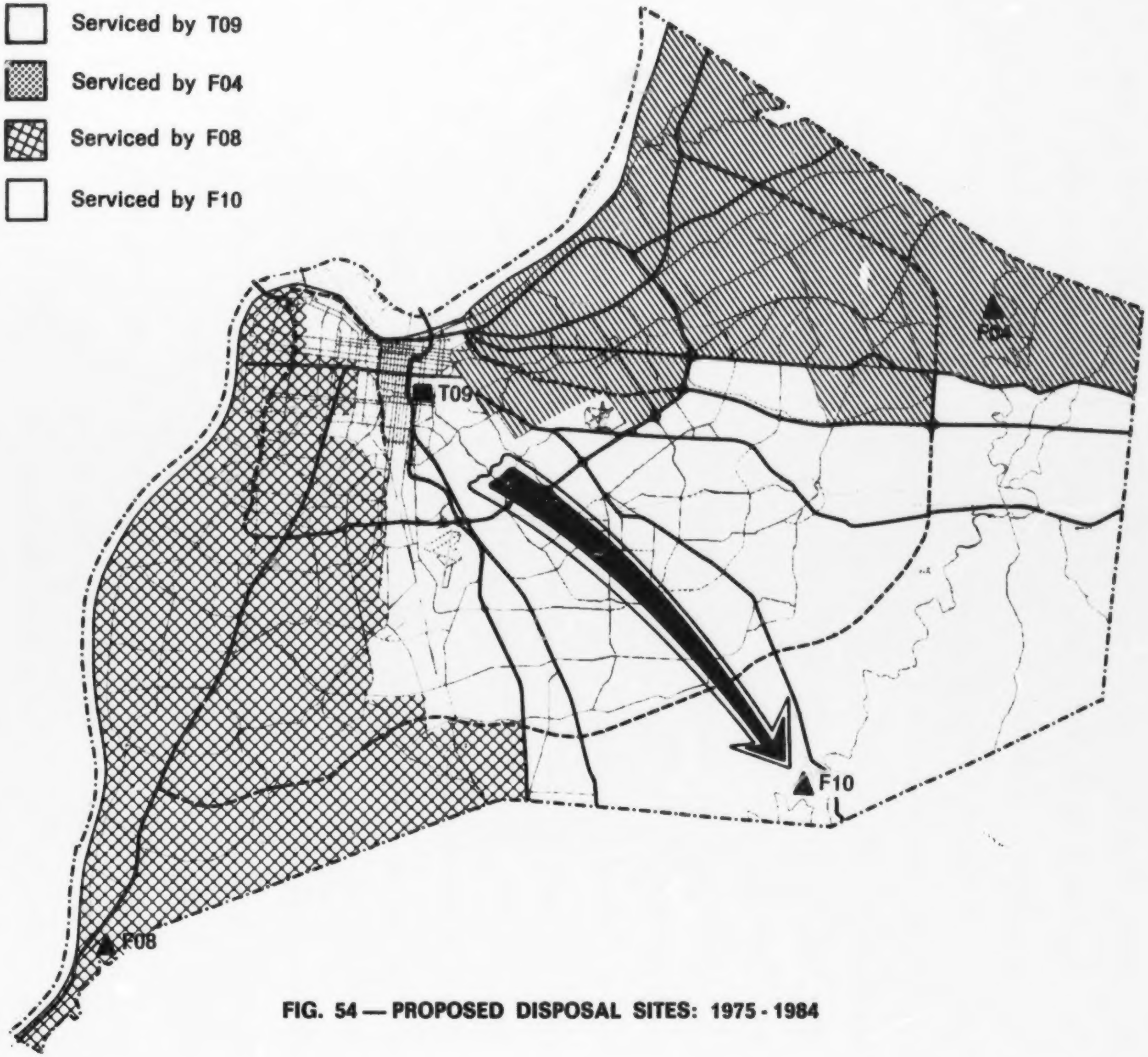

Serviced by T09
Serviced by F04
Serviced by F08
Serviced by F10
T09
F04
F10
F08

FIG. 54 — PROPOSED DISPOSAL SITES: 1975 - 1984

TABLE 37

Refuse Allocations - 1975-1984

Transfer or Disposal Site	Limits	Amount Allocated (tons per day)
T09	750	750
T10	750	0
F04	2500	826
F08	2500	1000
F10	2500	2006

4. Results, 1985-1994

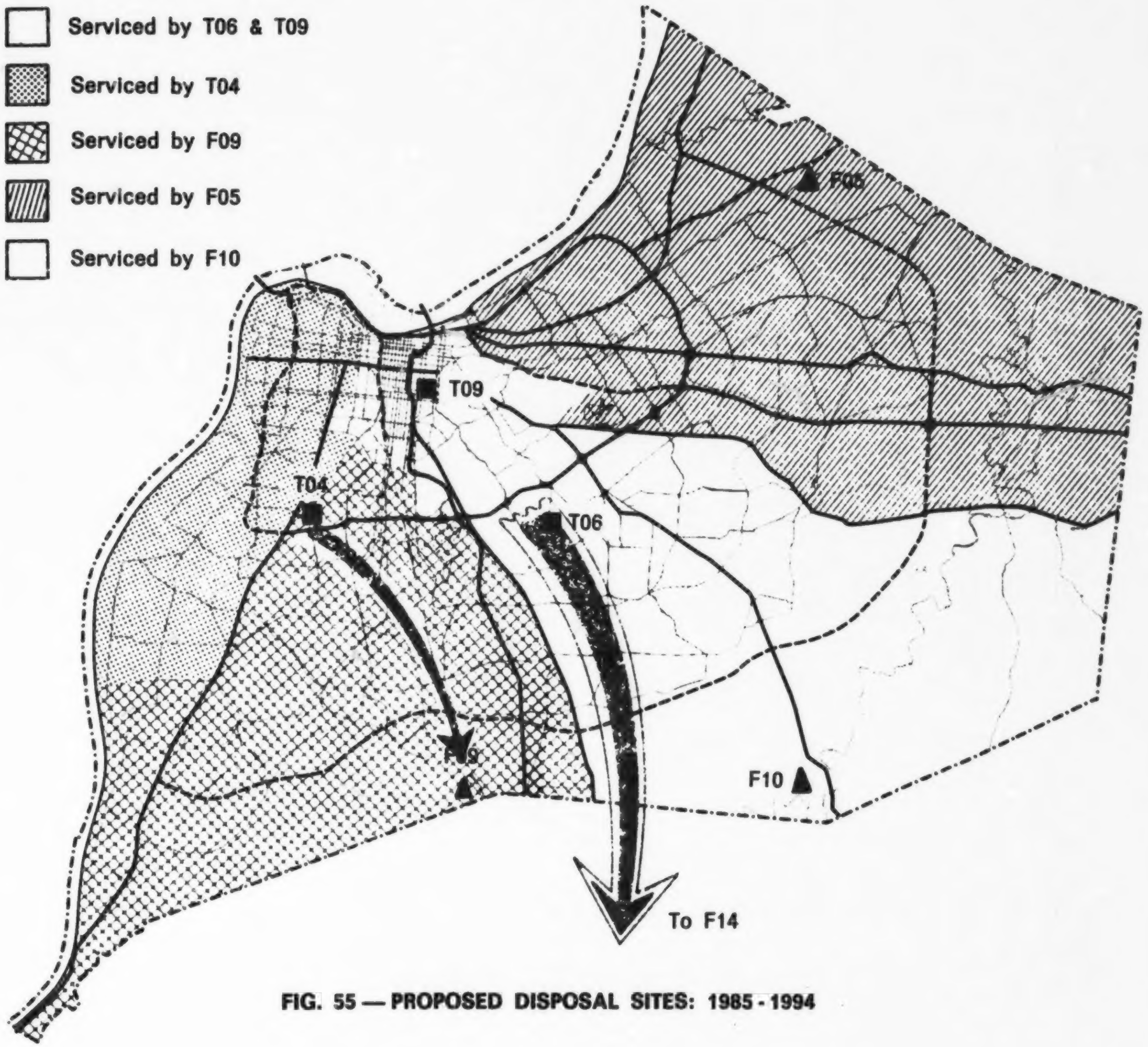
Since this design interval was so far in the future, a number of changed conditions were assumed to exist. Existing land use projections indicate that by 1990 or 1995 the county will be completely developed and will contain no rural areas. The areas considered feasible for disposal sites during the previous ten year period can be expected to contain low density residential development by this time. Although landfill operations within county boundaries would be technically feasible under such conditions, the costs will undoubtedly be much higher than at present because of stricter operating requirements made necessary by the proximity of residential areas. The landfill costs will be further increased by the fact that land would have to be purchased several years in advance and held idle until needed. For these reasons, it was estimated that the cost of all landfill operations within the county would approximately double by 1990.

It was assumed that the decrease in available sites within the county would make it mandatory to take some refuse beyond county lines. Accordingly, site areas F12 through F15 were established in the adjacent counties of Shelby, Oldham, and Bullitt. Since these new sites were located in rural areas, their cost of operation should be substantially less than sites within Jefferson County, and they were assigned a relative cost of 1.00 per ton.

Except for the city incinerator, all transfer relative costs remained the same as in the previous period. Earlier solutions had forced 750 tons per day through the incinerator because it had been assumed that it would continue in use until the end of the amortization period. By the 1985-1994 period the incinerator should be amortized. On this basis, the incinerator relative operating cost was increased to a more realistic 3.00 per ton and the relative operating cost of the alternate simple transfer site at that location decreased to 2.00 per ton, the value used for all other simple transfer sites. For this design period the incinerator was made to stand on its own merits.

Based on extrapolation of current price trends as shown in labor and material cost indices, the ratio between relative haul costs for collection and transfer vehicles was changed to three to one instead of the two to one ratio used for the other two design periods.

The results of the systems analysis for this final design period are given in Table 38 and Figure 55.


Serviced by T06 & T09
Serviced by T04
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F09
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To F14

FIG. 55 — PROPOSED DISPOSAL SITES: 1985 - 1994

TABLE 38

Refuse Allocations - 1985-1994

Transfer or Disposal Site	Limits	Amount Allocated (tons per day)
T03	1000	0
T04	1000	1000
T05	1000	0
T06	1000	303
T09	750	750
T10	750	0
F05	2500	826
F09	2500	2500
F10	2500	421
F14	2500	1057

PART VII: LAND REQUIREMENTS

190-B

VII. LAND REQUIREMENTS

VII-A. Effects of Refuse Composition

Less than half the refuse produced in Jefferson County can be classified as incinerable, and the theoretical ash content of the incinerable portion ranges from 15 per cent to 5 per cent on a dry basis. It is probable that the percentages of plastics, aluminum and glass will increase greatly in coming years. Although plastic and aluminum are melted during conventional incineration, they are generally considered a nuisance, causing many operational and maintenance problems. The daily quantities of refuse with no incineration and with theoretically perfect incineration of all combustibles is shown in Table 39.

TABLE 39

Comparison of Daily Refuse Quantities to be Landfilled

Year	Total Daily Refuse Quantity (tons)	Total Daily Quantity with Max. Incineration (tons)
1970	2870	1670
1975	3270	1900
1980	3660	2130
1985	4040	2350
1990	4420	2570

VII-B. Land Volumes Required

The estimated cumulative volumes of land required over the next twenty years for three alternative approaches, are shown in Figure 56. Assuming an average refuse fill depth of 20 feet, the acreage requirements are 875, 1250 and 1600 acres respectively. The lower of these three figures is based on theoretically perfect incineration, that is, the reduction of all combustibles to their laboratory ash contents. It is most unlikely that any conventional incineration process could achieve such efficiency.

VII-C. Cost Considerations

One new incinerator with a capacity of 1000 tons per day would cost between five and seven million dollars. Additional land requirements over a twenty year period without incineration are estimated to be about 350 - 400 acres and it is highly improbable that these land costs could ever equal the cost of new incinerator construction.

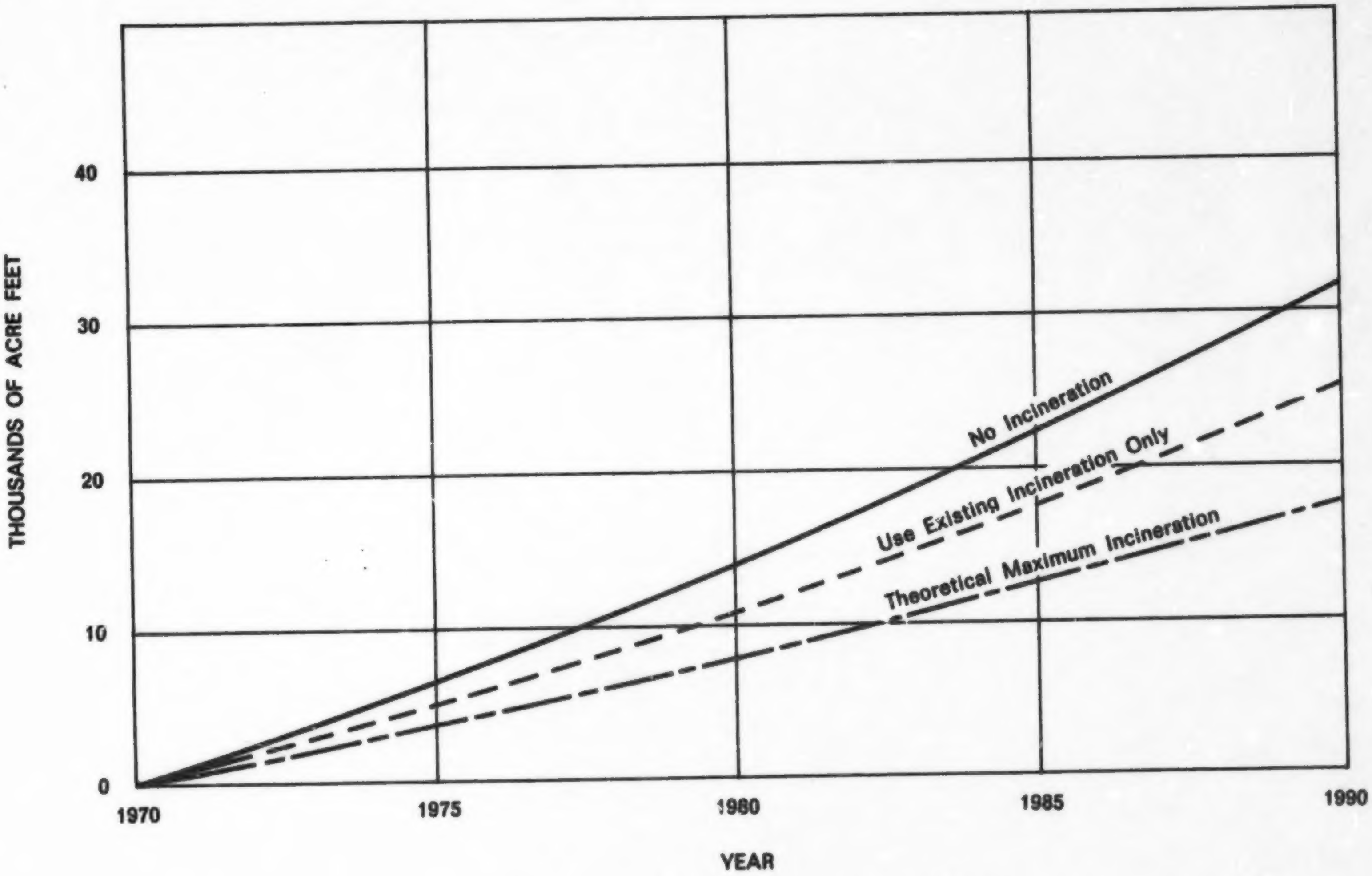
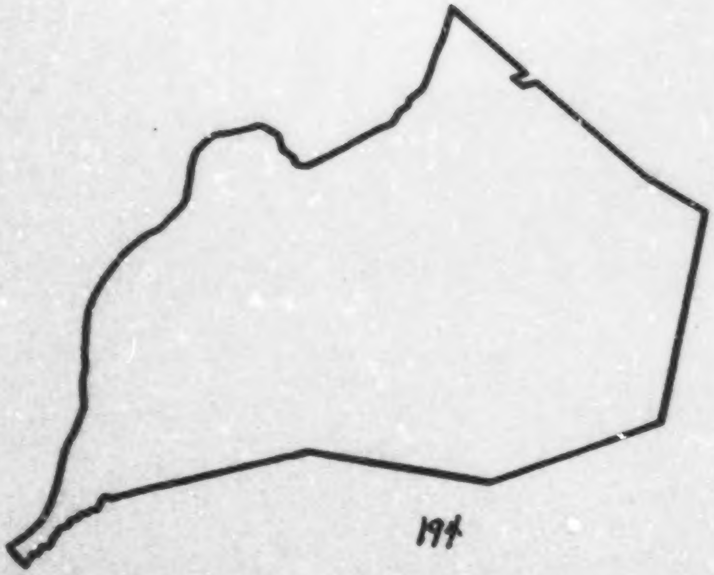


FIG. 56 — CUMULATIVE LANDFILL REQUIREMENTS

PART VIII: INVENTORY OF POTENTIAL DISPOSAL SITES



VIII. INVENTORY OF POTENTIAL DISPOSAL SITES

A. Landfill Sites

Section VII indicated that even with maximum incineration of refuse, Jefferson County will still require substantial landfilling facilities, both now and in the future.

1. General

Although the selection of specific landfill sites must, in the end, fall to those government officials responsible for implementing the recomendations of this report, certain representative locations were investigated to determine the availability of suitable sites within the general areas considered by the systems analysis. A description of these "sample" sites and the recommended mode of operation for each is discussed in this section.

2. Wet Woods Site

a. Site Description

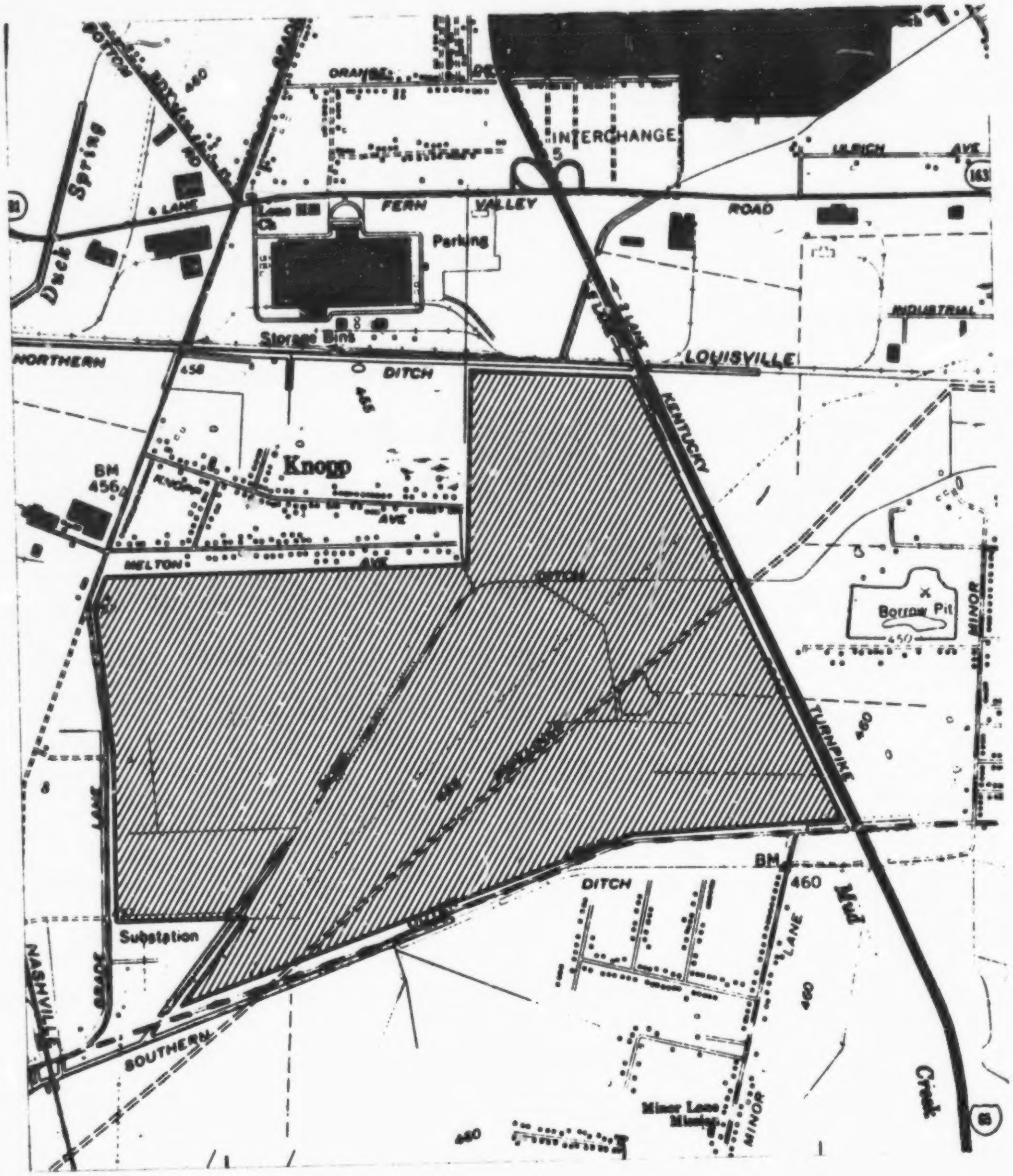
This site is an area of about 850 acres located in south-central Jefferson County just north of the Outer Loop and west of Interstate Highway 65 as shown in Figure 57. The area is bordered on the north by industrial firms and one small subdivision, and on the south by one small community. The area is generally swampy, and in its present condition is unsuitable for industrial or residential development. Rock is close to the surface and the water table is generally high all year round, but there is little ground water movement. Access to the site is excellent. It is located near the Outer Loop - I-65 interchange and direct access to the site is available from either the Outer Loop on the south or Grade Lane on the west.

b. Recommended Method of Operation

The soil available on site is less than ideal for final cover material, but would probably be suitable for daily cover requirements. The high water table and presence of rock at a shallow depth will make it difficult to use the trench method of landfilling. If adequate drainage of the site was provided, however, the trench method could probably be used, and would be preferred since fill capacity would be greatly increased. Adequate drainage of the site would be required not just for removal of surface water but for lowering the existing water table, especially for use of the trench method. The use of an impervious material at the base of the trench or area operation to prevent pollution of the groundwater would also be advisable. The area method could also be used, filling in three foot lifts and utilizing incinerator residue as daily cover material. The estimated daily load to this site is 1250 tons of combined refuse and 300 tons of incinerator residue. The fill should be raised two lifts or about seven feet above the existing ground elevation, and followed by a final cover of two feet of compacted earth.

c. Use of Completed Fill

After the site elevation is raised eight to ten feet, it could be used as an industrial site. The poor soil conditions presently existing would probably require any substantial structure to be set on short piles, so its use as an industrial site would not be hindered by using the site for sanitary landfill.


ORANGE
INTERCHANGE
ULRICH AVE
FERN VALLEY ROAD
Parking
Duck Spring
Storage Bins
NORTHERN DITCH
LOUISVILLE
INDUSTRIAL
KENTUCKY TURNPIKE
Knopp
BM 456
MELTON AVE
DITCH
Borrow Pit
450
MINOR
460
Substation
NASHVILLE
SOUTHERN
BM 460
LANE
Mud Creek
Minor Lane
65

Est. Area: 850 acres

Recommended daily load: 1250 tons combined refuse, 300 tons incinerator residue.

Est. Land Value: Recommended leasing in lieu of purchase.

Est. Life Expectancy: 10 - 15 years.

FIG. 57 - WET WOODS LANDFILL SITE

3. Jefferson County Memorial Forest Site

a. Site Description

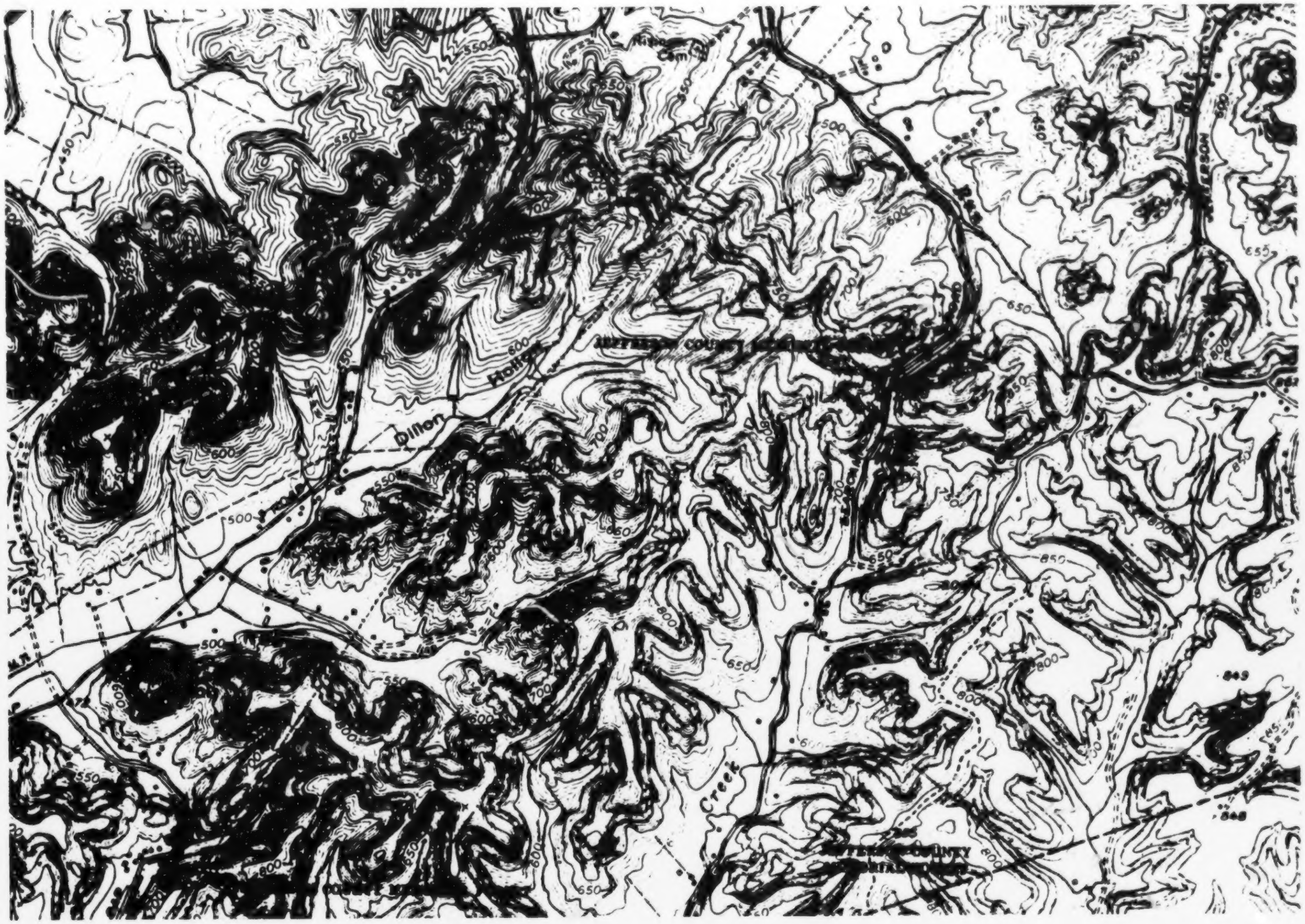
This site is an undeveloped 932 acre county park. It is located in the south western portion of the county just north of the Jefferson-Bullitt County line. Most of the site is wooded and the terrain is rough and hilly with numerous ravines. General access is via U. S. Highway 60 (Dixie Highway) to the west and National Turnpike on the east. The area is bordered on the north by Blevins Gap Road from which direct access can be obtained. Most of the soil in the area is a sandy silt which is suitable for cover. Though rock is occasionally present at shallow depths, sufficient cover material is available in some areas. A portion of this site area is shown in Figure 58 .

b. Recommended Method of Operation

It is proposed that the area method of landfill operation be used to fill ravines, using cover material available on site. The water table should present no difficulty but some form of erosion control should be provided because of increased surface run-off. The estimated daily load at this site is 150-200 tons of combined refuse per day until the present Lee's Lane site is exhausted, and then an estimated 1000 tons per day. At this rate the site has an estimated life expectancy of from ten to twenty years, depending on the extent of filling.

c. Use of Completed Landfill

The area has been designated by Jefferson County Planning Commission as future green space. The filled ravines could be made into recreation and picnic areas, making the site an excellent park.


Dillon
Hollow
Creek
JEFFERSON COUNTY
500
550
600
650
700
800
850

Est. Area: 932 acres.
Recommended daily load: 1969-1974: 200 tons per day; after 1974: 100 tons per day.
Est. Land Value: Already county owned.
Est. Life Expectancy: 10 to 20 years, depending on extent of filling.

FIG. 58 JEFFERSON COUNTY MEMORIAL FOREST SITE

4. Aiken Road Site

a. Site Description

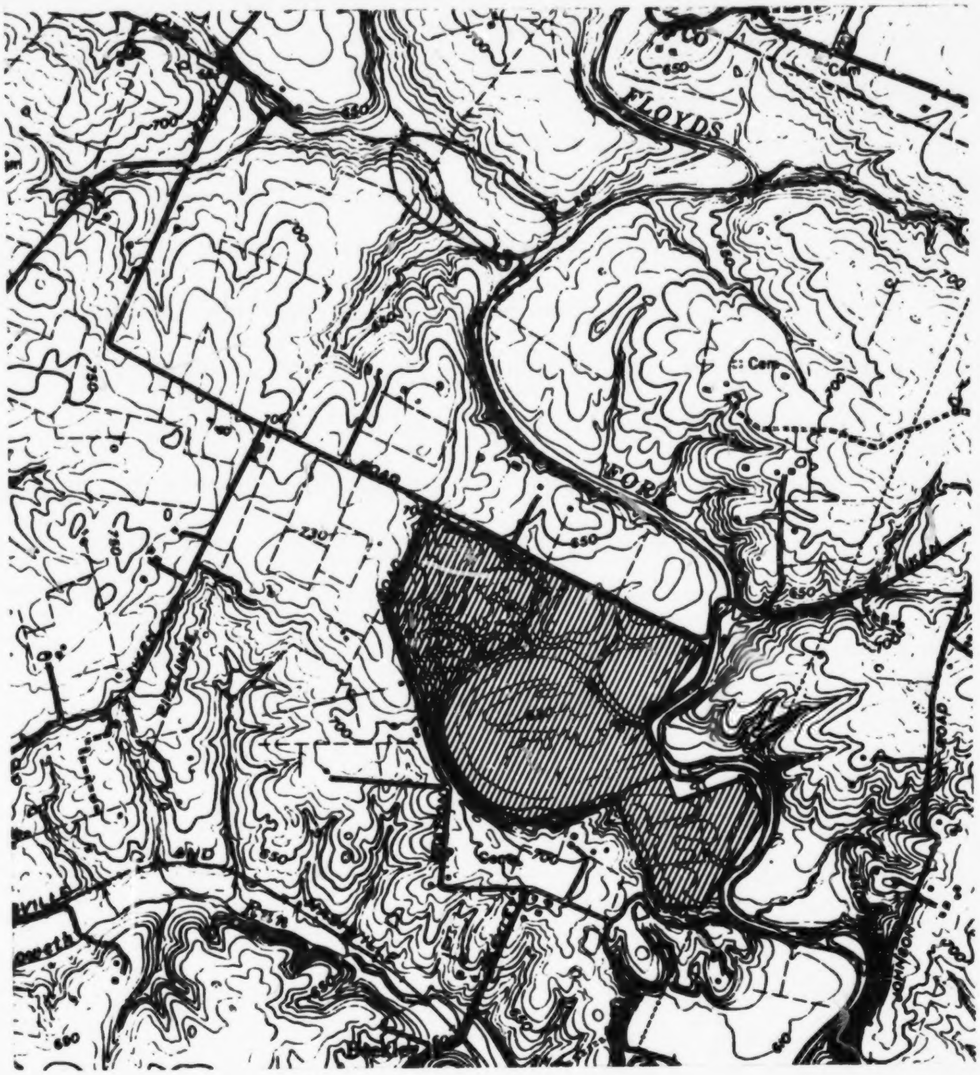
The main portion of this site is an ox-bow bend on the west side of Floyds Fork as shown in Figure 59. The proposed site contains an area of about 230 acres and is bounded on the north by Aiken Road and on the west and southwest by Beckly Station Road. General access to the area is available via Shelbyville Road. The soil at the site is a lean clay which is acceptable for use as cover material. The area is zoned for agricultural use and there are few houses in the vicinity.

b. Recommended Method of Operation

A combination of the trench and area methods of landfilling should be used at this site. To minimize the danger of ground water pollution the central area of the ox-bow bend should be filled by the area method, using cover obtained from the higher ground to the west and south. It will be necessary to construct a dike to exclude flood water. The dike should be built to the approximate final fill elevation. The anticipated daily loading of this site is an average of 300 tons per day between 1969 and 1974 and an average of 800 tons per day between 1975 and 1982 which is the end of the estimated life expectancy.

c. Use of Completed Landfill

This site is part of a proposed green belt area and upon completion of the landfill could be used for this purpose or for picnic and recreation sites.



Est. Area: 230 acres.

Recommended daily load: 1969-1974: 300 tons per day; after 1974: 600 - 800 tons per day.

Est. Land Value: $750/acre.

Est. Life Expectancy: 13 years.

FIG. 59 AIKEN ROAD SITE

5. Routt Road Site

a. Site Description

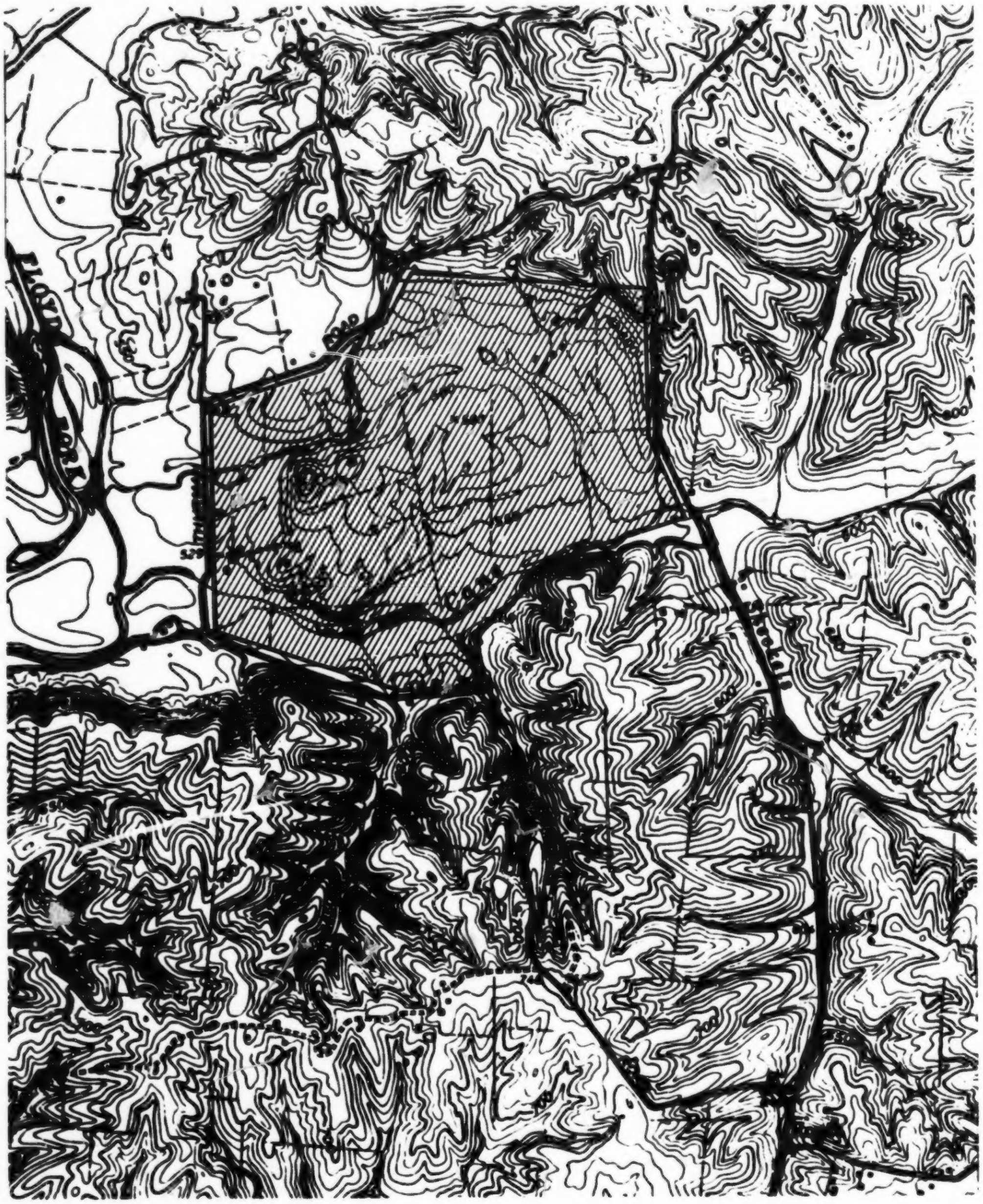
This site is an area of about 500 acres located in southeastern Jefferson County between Routt Road and Thurman Road. General access is via Taylorsville Road but direct access is available from either of the two roads bordering the area. This site does contain some buildings including several residences, but its general use is as farmland. The soil is predominately sandy silt. There is one small stream running through the area, and a small family cemetery is located on the site. Although the land has a relatively low assessed value the presence of the residential dwellings and the cemetery should raise land acquisition costs.

b. Recommended Method of Operation

The ramp method of landfilling should be used at this site. Careful control will be required to prevent intersecting the ground water table. A dike will probably be required at this site to prevent flooding during periods of high water. The site has an estimated volume of 4000 acre feet. Since this site is in an area other than those selected as optimum by the systems analysis it is offered as an alternative to the three previous sites.

c. Use of Completed Landfill

This site is also located in an area planned as green belt and should be used as such.



Est. Area: 500 acres

Est. Land Value: $750 per acre (excluding cost of buildings and cemetery relocation)

FIG. 60 ROUTT ROAD SITE

6. Old Heady Road Site

a. Site Description

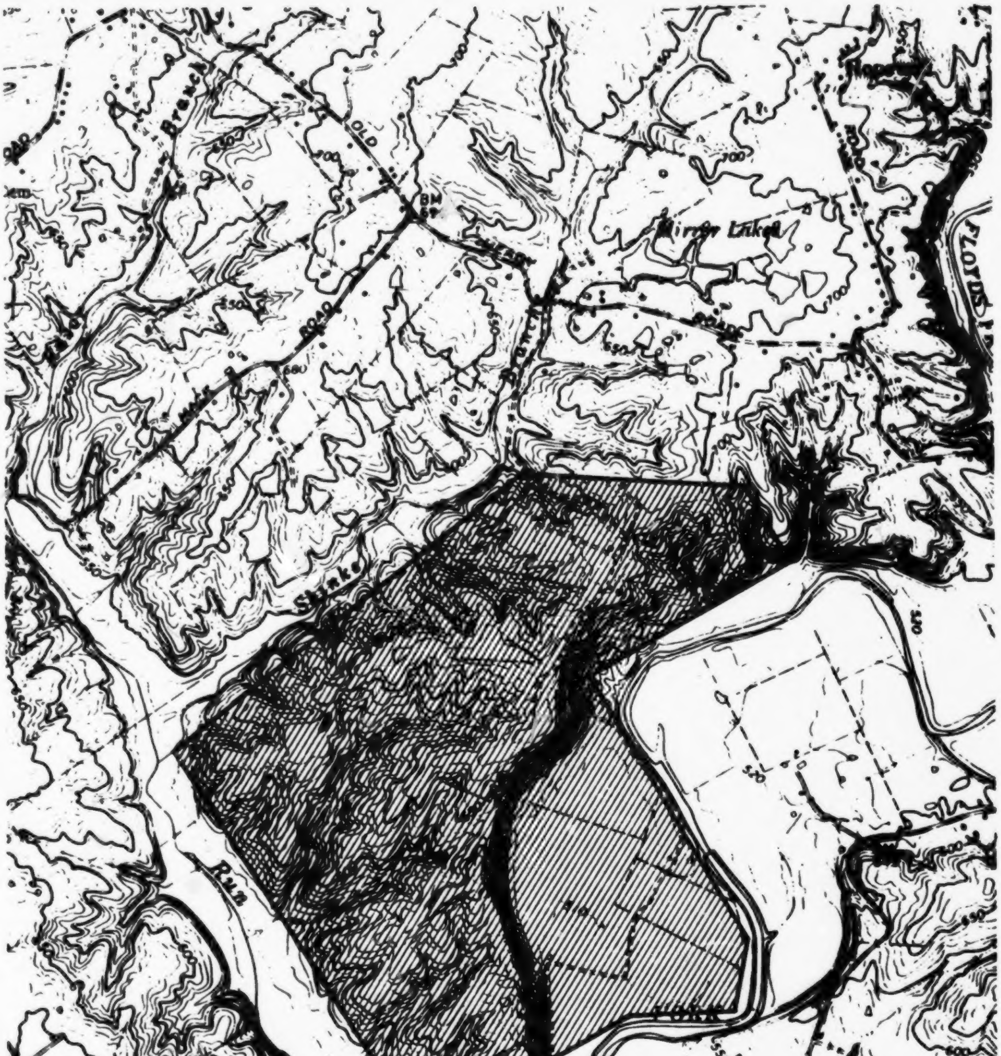
This 800 acre site is located in south eastern Jefferson County on the west side of Floyds Fork. The area is bordered on the northeast by Old Heady Road and on the northwest by Mack Road and Shinks Branch Creek. General access is via Taylorsville Road and direct access via Old Heady Road. The site does contain a few buildings and is zoned for agricultural use. The western portion of the site is hilly with several sizeable ravines having as much as 100 feet of relief. About 150 acres of the site is part of the Floyd Fork flood plain.

b. Recommended Method of Operation

The ramp method is the preferred landfilling technique for the majority of the site which consists of deep ravines. Suitable cover may not be available throughout the area and may have to be hauled from elsewhere. That portion of the site in the flood plain should be filled using the area method. A dike will be required to exclude flood water, and downstream portions of Floyd Fork should be monitored to detect any increase in water born pollutants due to the presence of the landfill. This site is not in an area indicated as optimum by systems analysis and is offered only as an alternate site.

c. Use of Completed Landfill

As with other sites in this area, the completed fill should be used as green space.


Branch
OLD
ROAD
BM
Mirror Lakes
FLOYDS
Shinks
Run
FORK
Seatonville
500
550
600
700

Est. Area: 800 acres.

Est. Land Value: $750/acre.

FIG. 61 OLD HEADY ROAD SITE